COST ASSESSMENT FOR SUSTAINABLE ENERGY SYSTEMS

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Newsletter of the CASES project

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Editorial

Recent macroeconomic problems are affecting the world economy by reducing the growth forecast for next years. Meanwhile experts are predicting an environmental emergency caused by energy-related emissions that affect human health, the ecosystems and cause climate changes.

There is a perception of a trade-off between policy instruments chosen to avoid the economic crisis and instruments chosen to improve environmental sustainability. This perception is particularly strong for developing countries; sustainable environmental policy is treated as an obstacle to industrial development and welfare improvement for all citizens.

However, conclusions may change if environmental damage costs are assessed in monetary terms, from an economic point of view. A new way for economic growth that is also sustainable from an environmental perspective may be followed if the external costs are added to the industrial cost of generating goods or services, which have an impact on human health and on environment.

The energy sector has a key role to sustain the economic growth of a country, but in producing electricity many dangerous substances are emitted to air, soil and water. The CASES project focuses on the efficiency of the electricity market. CASES assess as the full costs analysis of electricity generation, by summing damage costs and private cost.

After almost 20 months from the beginning of CASES project, the final estimates on private and external costs of electricity generation are now available. The project started by assessing methodologies, reviewing literature and updating tools. Then the full cost of production for different energy sources at the national level for the EU-27 Countries and for some others countries was determined from the present until 2030.

With the support of this complete cost database, policy instruments will be evaluated to choose the best ways to improve an energy system sustainable from an economic, social and environmental point of view.

The project coordination team

Fondazione ENI Enrico Mattei

In this issue

News from CASES

CASES is a coordination action funded by the European Commission (FP6, Sustainable Energy Systems, 2006-2008). It evaluates policy options for improving the efficiency of energy use. Underpinning this evaluation is a consistent and comprehensive database of the full cost of energy. One of the objectives of the project is to make this crucial knowledge available to all stakeholders.

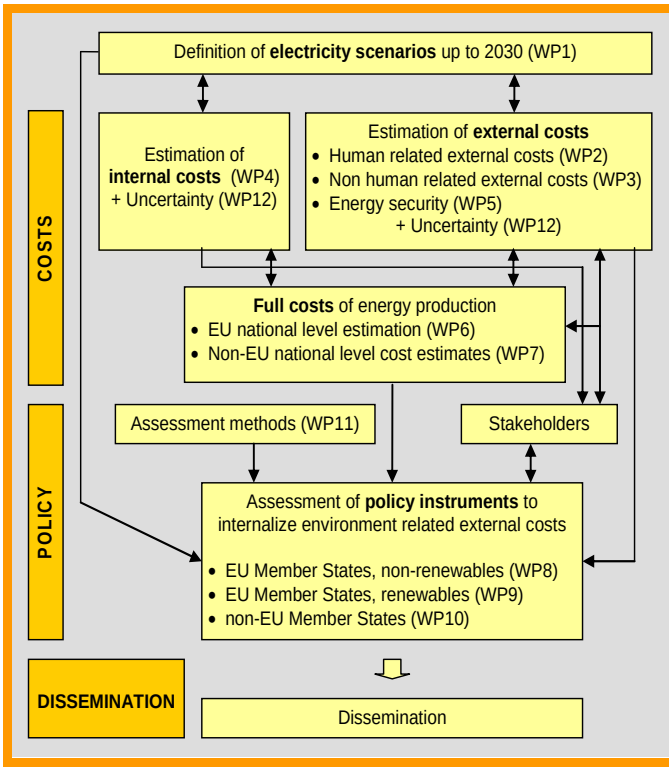
In particular CASES compiles a complete and detailed estimate of both private and external costs - including energy security costs - of electricity generation. The set of assessed costs covers a wide set of technologies for electricity production for all the EU-27 Countries and some non-EU Countries, under well defined energy scenarios to 2030. Hence, the full cost of electricity production for each technology is calculated by considering the private costs and all external costs.

The cost database provides a crucial quantitative support to the assessment of alternative policy options in the perspective of improving the efficiency of energy use. CASES will provide a set of recommendations on the use of different policy instruments for the internalisation of the external costs of energy production. Hence the project contributes directly to policy and provides an information base on the effectiveness and on the consequences of the use of different instruments.

Finally the project disseminates research findings to energy sector producers and users, and to the policy-making community.

Work in progress

The structure of the project is divided in two main research areas: one concerns cost assessment and the other policy evaluation. More in detail CASES is built as a series of "Work Packages" (WP) each corresponding to a specific topic, which are strictly connected as it is shown in the next figure.



Structure of the project and interaction between the WPs.

The project started on 1st April 2006 and its duration is 30 months. During the past months the work has concentrated on estimating private and external costs of electricity generation. Homogeneous data templates are obtained, detailed for country and for technology of full cost of energy, including private and all external costs, under electricity scenarios up to 2030.

The next steps of the project are to define and assess the policy instruments for the internalisation of externalities in Europe and in some non European countries.

Results and deliverables

During the past months a number of reports and databases were produced. Brief summaries of these deliverables are presented in this section. For additional details, all deliverables can be fully downloaded from the CASES website at the following web-address:

http://www.feem-project.net/cases/downloads_deliverables.php

Report on National and EU level estimates of energy supply externalities

Steven Arnold, Alistair Hunt and Anil Markandya. [i]

Adriaan van der Welle and Bob van der Zwaan[ii]

This report is composed by two sections.

Section 1 reviews the evidence on the macro-economic costs of energy price fluctuations and their impacts on the EU. The majority of the evidence (modelled or observed) relates to the macro-economic costs – in terms of lost GDP – from oil price increases that last at least six months. When these costs are apportioned to EU electricity consumption, they are negligible, a mid-point result being €0.000004 per kWh within a range of €0.000001 - €0.000008. The absence of empirical evidence, however, has meant that impacts of short term oil price fluctuations and the potential impacts of equivalent price movements in gas or coal are not quantified.

Section 2 provides an overview of some of the recent literature on the Value Of Lost Load (VOLL). VOLL as monetary expression for the costs associated with inter- or dis-ruptions of electricity supply, as a result of production, transmission or distribution failures, can be a useful variable that allows for the quantification of one of the dimensions of energy supply security of a country, region or economic sector. Through our literature review and a closer inspection of a selection of the most quoted references, we find that figures for VOLL are almost certainly laying in a range of 4-40 $/kWh for developed countries and 1-10 $/kWh for developing countries. With still a high level of confidence these ranges can be narrowed down to, respectively, 5-25 $/kWh and 2-5 $/kWh. We also carefully conclude that these ranges seem left-skewed.

Report on policy assessment of energy security measures incorporating externality

Arno Behrens and Christian Egenhofer[iii]

This paper outlines policy options to reduce insecurities associated with the EU's energy supply. After classifying and analyzing the security of supply risks in the EU, it will briefly describe those measures adopted by the EU in the European Council Action Plan[iv] and the related Energy Policy for Europe (EPE). Chapter four will give a comprehensive overview about the most important market-compatible, economic risk-management strategies, in which responsibility is shared among Member States, the EU, energy companies and customers. An effective energy policy, however, cannot solely rely on markets. Especially for the long-term policy objectives government action will be needed, as laid out in chapter five.

Report on the monetary valuation of energy related impacts on land use changes, acidification, eutrophication, visual intrusion and climate change

Onno Kuik, Luke Brander and Nataliya Nikitina [v]

Ståle Navrud and Kristin Magnussen [vi]

El Hadji Fall [vii]

The external costs of energy production include a number of items that have hitherto proved hard to put a monetary value on. The cost items include the external value of land use change, acidification of the aquatic environment, eutrophication, and visual intrusion. There is also still considerable uncertainty on the damage costs of climate change. In relation to climate change, but also to other dynamic elements in the power sector, the rate of discount or the discount factor to compute the present value of future costs and benefits has attracted much attention.

This report screens recent literature in these areas on information regarding these costs that can be used at the European level. Information on these costs is commonly found only in a limited number of studies, covering a limited geographical region, and considering a limited number of ecosystem types and functions. Therefore, this report also discusses the technique of 'benefit transfer' to transfer values or functions that were assessed in 'study sites' to other sites across Europe. The primary objective of the research is to find data and functions that can be built in the EcoSense model, the computer model that is used by the CASES project to

assess the external costs of power generation in scenarios over the period 2005-2030.

Private costs of electricity and heat generation

Markus Blesl, Steffen Wissel, Oliver Mayer-Spohn[viii]

The objective of this workstream is to present best predictions about the evolution of the private costs of different technologies of electricity and heat generation up to 2030. Chapter 2 illustrates the methodology for determination of private costs, on the basis of the Average Levelised Generating Costs (ALLGC). The energy price assumptions of the fossil nuclear energy systems are briefed in the following chapter of the report. Chapter 4 is a broad look at the current most important technologies and potentially future (most important) technologies of electricity and heat generation. Each of these technologies has been scrutinized, especially with regard to its potential for further development in the future. Chapter 5 represents analysis about the preliminary results of private costs of selective heat and electricity generation technologies.

Updated database on life cycle emissions for electricity and heat generation technologies from present to 2030

Markus Blesl

For each electricity generation technology a process chain analysis was performed. This analysis subdivides the process of electricity generation into four sub-processes representing the life cycle phases: "power plant construction", "fuel supply", "power plant operation" and "power plant dismantling". The database reports for each life cycle stage the emissions produced to generate electricity. The data are average value for all Europe and are detailed for the following years: 2005-2010, 2020 and 2030. The technologies analysed belong to the following groups: nuclear, fossil fired power plants, renewable and CHP. The emissions' list includes air, water and soil pollutants, in addition to land use change.

External costs calculation of Energy Lifecycle: EcoSenseWeb V1.3 Tool and database on marginal costs of emissions

Philipp Preiss[ix]

The methodology to estimate external costs of energy, which was developed by the ExternE project from 1995, have been successfully improved and updated. These improvements include new dispersion model, a new set of concentration response functions regarding human health impacts and monetary values for the evaluation of the risk of reduced life expectancy, new monetary values for marginal damage and avoidance costs of released green house gases, and a methodology to account for loss of biodiversity due to land use change, acidification and eutrophication.

The new methodology allows the IER team to update the tool EcoSenseWeb V1.2, which is used to calculate external costs.

By using EcosensEWeb the "Euro per Ton" estimates for classical air pollutants and some other pollutants where obtained for present and for 2020. The currently available values for classical air pollutants correspond to an average height of release. The values are based on parameterised results of a complex dispersion model. Results are available for emission of NH3, NMVOC, NOX, PPMcoarse, PPM2.5, SO2. Results are available for 39 European and non-European countries and 5 sea regions, and for the EU27 as an average. The receptor domain covers the whole of Europe regarding impacts to human health, crops, damage to materials "Loss of Biodiversity" caused by acidification and eutrophication, newly implemented into the assessment framework.

Report on uncertainties and their effects

Bob van der Zwaan[x], *Ari Rabl*[xi]

A simple and transparent method for the uncertainty analysis of damage cost estimates is presented and applied to the damage cost of the classical air pollutants. The uncertainty is characterized in terms of geometric standard deviations σ_g and multiplicative

confidence intervals: if a cost has been estimated to be μ_g (geometric mean ≈ median) with geometric standard deviation, the probability is approximately 68% that the true value is in the interval $[\mu_g/\sigma_g, \mu_g.\sigma_g]$ and 95% that it is in $[\mu_g/\sigma_g^2, \mu_g.\sigma_g^2]$. For NO_x, SO_2 and PM_{10} σg is about 3. For CO_2 and climate change we estimate the uncertainty on the basis of a literature review. The literature review indicates a σ_g of about 5.

The effect of the uncertainties on several policy choices is evaluated, in particular on the optimal levels for national emission ceilings. We also evaluate the benefit of reducing the uncertainties by further research (to help identify the priorities for such research).

Development of a set of full cost estimates of the use of different energy sources and its comparative assessment in EU countries

Roberto Porchia, Andrea Bigano and Anil Markandya[xii]

Part one of this report provides a literature review on methodology and results on private and external cost calculation. The literature review assesses costs of electricity generation for each EU-25 country, plus Romania and Norway. For some countries a brief overview of electricity production in the country and a foreseen on electricity production evolution until 2030 introduces the cost assessment.[xiii]

Part two provides estimates, updated to 2007, on full costs of electricity generation in Europe. The results are obtained for present, for 2020 and for 2030 by summing external costs on human health, environment, crops, materials and climate change to private generation costs. Full costs were calculated and assessed for a wide set of technologies, which includes nuclear and fossil fired power plants, renewables and combined heat and power plants. Full costs are assessed as average values of all EU-27 countries; in addition a country specific analysis is presented for external costs.

Results indicate that, in 2005-2010, the least expensive technologies are nuclear (European pressurized reactor) and hard coal Combined Heat and Power with a European average full cost of 3.1 Eurocents per kWh. These technologies are followed by hydroelectric power plants with a full cost of 4.63 Eurocents per kWh, biomass and gas CHP. This rank will not change significantly in the next years. For 2030 it is foreseen that the least expensive technology will be coal CHP with a price of 2.47 Eurocents per kWh.

The most expensive technology is solar photo voltaic, which has a full generation costs from 51 up to 73 Ec/kWh at present. However a strong reduction of generation costs is foreseen in the next 20 years for these technologies thanks to investments in technological improvement.

In the analysis performed, private and external costs are assessed for the whole life cycle of the power plant, from construction to dismantling, including cost of extraction and transportation of fuel and waste disposal. Private costs and quantity of pollutants emitted, which are plant specific, are calculated for new power plants build in 2005-2010, in 2020 and 2030.

National reports on private and social costs of fuels cycles in the non-EU countries and cross-country comparison

Xianli Zhu, Lars Rosendahl Appelquist and Kirsten Halsnæs[xiv]

National methodologies and estimates of social costs of energy generation are assessed for selected non Eu countries in the following reports:

- Report on private and social costs of fuels cycles in Brasil[xv]
- Fossil fuel power production and renewable energy private and social costs for Bulgaria[xvi]
- External Cost Analysis for Coal and External Cost Analysis for Gas in China[xvii]
- Fuel Life Cycle for India[xviii]
- Lignite and Biodiesel Fuel Cycle for Turkey [xix]

For all five countries, the external impacts quantified for coal and natural gas are often air pollution and GHG emissions, as well as solid waste and liquid waste. This

shows that for external cost studies, these cost results are most readily available.

Except for Brazil, which focuses on a health impacts assessment, the other four countries do not follow the damage function approach of ExternE. This shows that the later steps of the ExternE damage function approach, namely: 1) Dispersion: to estimate scope and degree of impacts done, by taking into account the local climate and geographic situations and 2) definition of dose-response functions, are more difficult to implement in the fuel life cycle case studies among the five countries. The last valuation step is mainly based on levels of emission charges set by the governments or the prices or charges used in the US. As a result, the study results do not consider the local population, climate, vegetation and geographic situation. When external costs are estimated on the basis of local government emission charges, the results are actually the shadow costs or opportunity costs taken into account by economic agents when deciding whether to take emission reduction measures or not.

Multi Criteria Decision Analysis (MCDA) tool-generic form for policy assessment

Danae Diakoulaki and Christos Tourkolias [xx]

The MCDA tool is set up for implementing assessment method for policy analysis in an interactive and dynamic way. This tool is developed in a generic form assuming a number of alternative policy instruments evaluated along a number of criteria. The tool comprises the following interactive elements:

- The list of criteria taken into account for the evaluation of policy instruments.
- The list of policy instruments.
- The evaluation matrix presenting the performances of each instrument in the defined criteria.
- Two weighting methods facilitating the user to define the relative importance of the agreed criteria. The user is asked to select the most convenient method, or to use both of them in order to confirm the results.
- The resulting multicriteria ranking and classification of policy instruments.

Performances will be assessed on a qualitative scale. To this purpose, all partners involved in in the policy assessment part of the project, have contributed to set-up a questionnaire to be properly completed for deriving the performances of policy instruments along the evaluation criteria.

Past and forthcoming events

Mid term project meeting in Brussels

All partners of the consortium meet in Brussels to review the results reached during the first year of the project and to plan the further steps of the project. The meeting was organised and hosted by CEPS on 2nd and 3rd July 2007. The second meeting of the Project Steering Committee was held during this event.

Forthcoming events

- The First Stakeholders **Workshop on "Cost of Energy Assessment"** will take place the 18th February 2008 in Brussels. A project meeting and the third Steering Committee meeting will follow the event on 19th February. The event is organised by USTUTT/IER.
- Second Stakeholders Workshop on "policy assessment", and Mid-term Project Meeting (second Annual Review) including forth Project Steering Committee meeting, scheduled in April 2008, to be organised by VITO.
- Final Conference and final Project Meeting, including fifth Project Steering Committee meeting, scheduled in August 2008, to be organised by ISIS.

Partners' list

Project co-ordinator

1. Fondazione Eni Enrico Mattei (FEEM)

Project Consortium

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3. National Technical University of Athens (NTUA)
4. University of Stuttgart – Institute of Energy Economics and the Rational Use of Energy (USTUTT/IER)
5. Flemish Institute for Technological Research (VITO)
6. Technical University of Denmark – Risoe National Laboratory (DTU/RISOE)
7. Observatoire Méditerranéen de l'Energie (OME)
8. University of Flensburg (UFLENS)
9. Energy Research Centre of the Netherlands (ECN)
10. Vrije Universiteit Amsterdam-Institute for Environmental Studies (VU/IVM)
11. Econ Pöyry AS (ECON/POYRY)
12. Fundação COPPETEC (COPPETEC)
13. SWECO Grøner as (SWECO)
14. Lithuanian Energy Institute (LEI)
15. Indian Institute of Management Ahmedabad (IIMA)
16. Energy Research Institute (ERI)
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18. Univerzita Karlova v Praze - Charles University Enviroment Center (CUEC)
19. Centre for European Policy Studies (CEPS)
20. University of Warsaw - Warsaw Ecological Economic Center (UWARS)
21. Energy Agency of Plovdiv (EAP)
22. Turkiye Bilimsel ve Teknik Arastirma Kurumu - Marmara Research Center, Institute of Energy (TUBITAK)
23. Wageningen Universiteit (WU)
24. Istituto di Studi per l'Integrazione dei Sistemi (ISIS)
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The Consortium of the CASES' Co-ordination Action is lead by Fondazione Eni Enrico Mattei (FEEM) and it is composed by twenty-five partners established in twenty States, it covers the whole European area and also involves three institutions in two developing continents (Asia and South America).

Most of the institutions are established for research activities (11) and for higher education (9). The other participants are not qualified in one particular activity but they provide a scientific expertise and carry out complementary activities necessary to achieve the objectives of this Co-ordination Action.

Contacts

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http://www.feem-project.net/cases/

Present and past Newsletters are available online

http://www.feem-project.net/cases/downloads_newsletter.php

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