Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

Cost and benefit effects of renewable energy expansion in the power and heat sectors

1. Basic issues / Methodological principles

Since the 1990s, the expansion of energy from renewable sources in Germany has been accompanied by a vigorous discussion about its impacts on businesses, households and the economy as a whole. The main focus here has been on the cost of this expansion, and especially on the heat and electricity generation costs from renewable energy associated with the Renewable Energy Sources Act (Erneuerbaren-Energien-Gesetz – EEG). Criticism has recently been fuelled by the expected substantial increase in the EEG surcharge in 2010 and indications of possible further drastic increases in the years to come.[1] In contrast, any benefits associated with the expansion of energy from renewable sources have tended to take a back seat. What is more, until now, the diversity of the effects and their many dimensions have resulted in the lack of a comprehensive, scientifically based overall picture of the effects that a cost-benefit analysis can provide.

It was against this background that, in 2008, the Federal Ministry for the Environment assigned a multi-year scientific project to a team led by the Fraunhofer ISI in Karlsruhe. This is intended to improve the methodological basis for an integrated, economically sound analysis of the costs and benefits of renewable energy sources, among other things by extending the analysis beyond the usual focus on the electricity sector to include heat supplies from renewable sources. As far as possible, the study is to undertake quantitative assessments.

[1] For further information, see also www.erneuerbare-energien.de/inhalt/45415/4590/

A first interim report on the project was published in March 2010.[2] This shows that a soundly based overall economic assessment of renewable energy sources needs to take account of a wide range of aspects and interactions:

Firstly, the scope of the analysis is an important aspect: Is it concerned simply with the expansion of energy from renewable sources in the electricity sector, or does it – like the present study – include other areas of renewable energy supply? It is also important when analysing electricity generation from renewable sources to bear in mind that not all of it is paid for in accordance with the Renewable Energy Sources Act. In addition to some of the electricity generated from hydro power and biomass, this is increasingly true of power from renewable sources that is used for internal purposes or marketed directly. Heat generation from renewable sources is also only partly subsidised.

It is also necessary to differentiate by impact category: In the case of support of electricity under the EEG, which have tended to be the focus of attention in the past, the practice of passing on EEG additional costs via the EEG surcharge increases customers' electricity bills. However, this has to be set against the corresponding revenue for plant operators and, where appropriate, for power suppliers, which means that this is just a distributional effect (see below). On this basis alone, it is not possible to reach any final judgement about EEG support. Therefore, other categories such as macroeconomic effects or a systems-analysis approach have to be considered.

A more meaningful approach for a comprehensive analysis is to make a systems analysis of the cost and benefit effects associated with the EEG and its expansion. On the costs side, this does not consider funding rates and energy exchange prices, but compares the electricity production costs of renewable energy (RE) technologies with the fossil options that are available. If the additional costs determined in this way are supplemented by a number of other indirect costs of EEG expansion (grid expansion and transaction costs; in the electricity sector particularly basic/ balancing energy), one arrives at a cost figure that can be compared with the specific benefit effects of renewable energy expansion in a systems analysis approach.

On the benefits side the dominating factor is the environmental damage avoided by using renewable energy. Before undertaking any accounting/netting operations,

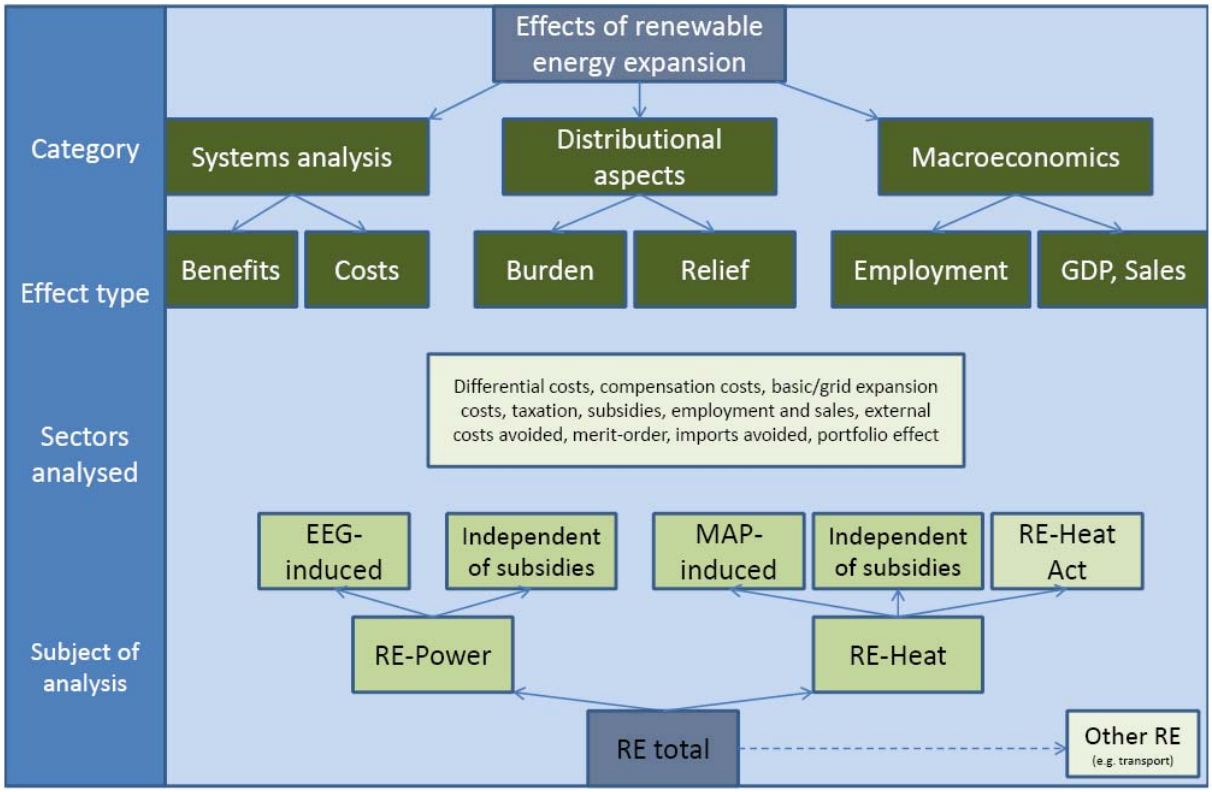
[2] Fraunhofer-Institut für System- und Innovationsforschung (ISI), Karlsruhe; Gesellschaft für wirtschaftliche Strukturforschung (GWS), Osnabrück; Institut für ZukunftsEnergieSysteme (IZES), Saarbrücken; Deutsches Institut für Wirtschaftsforschung (DIW), Berlin: Einzel- und gesamtwirtschaftliche Analyse von Kosten- und Nutzenwirkungen des Ausbaus der Erneuerbaren Energien im deutschen Strom- und Wärmemarkt – Zwischenbericht zu Arbeitspaket 1 (Bestandsaufnahme und Bewertung vorliegender Ansätze). Study commissioned by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Report (in German) available from http://www.erneuerbare-energien.de/inhalt/45801/45802/

these benefits have to be assessed in monetary terms; it is also necessary to examine whether and to what extent these effects may have been at least partially taken into account (internalised) within the economic system by other environmental or energy policy instruments. Both steps in the analysis are very demanding from a methodological point of view. The same applies to the portfolio effect of renewable energy expansion which can also be regarded as a benefit item. This describes the fact that the use of different power generation capacities can minimise risks for a given yield – an effect which, however, has yet to be quantified.

In addition to the parameters already specified under the systems analysis approach, there is a large number of other effects that are relevant to the economic assessment of renewable energy, most of which can be assigned to two other impact categories: Distributional aspects indicate which economic actors or groups enjoy benefits or suffer burdens as a result of the support for renewable energy expansion. As well as the effects of the EEG and other funding instruments already mentioned, these include the “merit-order effect” in particular. In addition, national or sectoral growth effects can be classified as macroeconomic effects, a further category that encompasses the effects of renewable energy expansion on GDP and/or employment.

Finally, the expansion of energy from renewable sources involves other effects which cannot be assigned clearly to any of the three main categories already mentioned. They are nevertheless important for the economic and political assessment of renewable energy. They include the possible effects of renewable energy expansion on innovation intensity, for example in the field of renewable energy technologies, spill-over effects in the technical and political fields, impacts on environmental awareness, changes in social norms with regard to ideas about climate protection, and advantages of renewable energy for internal and external security. In-depth discussion of such effects could place the benefits of renewable energy expansion on a broader footing.

The following diagram provides an overview of the aspects outlined above. It is important to remember that a quantitative comparison of individual parameters is only possible within the three main impact categories shown.



Source: ISI/GWS/IZES/DIW (Footnote 2), p. 27

2. Overview of cost-benefit effects for 2008 and 2009

The following table provides an overall picture of the most important cost and benefit factors of renewable energy expansion that have so far been quantified. The above mentioned interim report usually refers to the year 2008.[3] In June a short paper with updated key figures for 2009 has been published.[4]

[3] For more details see the interim report on the above-mentioned projects (cf. Footnote 2), especially the summary provided there (p. 1 – 23).

[4] This update also contains some slightly amended 2008 figures mentioned in the interim report due to new data. See: ISI/GWS/IZES/DIW: Einzel- und gesamtwirtschaftliche Analyse von Kosten- und Nutzenwirkungen des Ausbaus erneuerbarer Energien im deutschen Strom- und Wärmemarkt. Kurz-Update der quantifizierten Kosten- und Nutzenwirkungen für 2009. Mai 2010. Report (in German) available from www.erneuerbare-energien.de.

Selected key figures for the economic analysis of renewable energy expansion in Germany in the heat and power sectors in 2008

Systems analysis approach of cost and benefit aspects

Costs		Benefits	
Differential costs, electricity	4.3 bn EUR		
Basic/balancing energy	*0.6 bn EUR*		
Grid expansion	*0.02 bn EUR*		
Transaction costs	*0.03 bn EUR*		
Total, electricity	5 bn EUR	5.9 bn EUR	Environmental damage avoided by renewable energy power (gross)
Differential costs, heat	1 bn EUR	2 bn EUR	Environmental damage avoided by renewable energy heat (gross)
		n.q.	Portfolio effects
Total[1)]	6 bn EUR	7,9 bn EUR	

Note: Italics in cases where data only available for 2007

[1)] Partly due to different base years, it is not yet possible to make a clear statement of the balance of the systems analysis of the costs and benefits for 2008 or to show the gross benefits.

Distributional effects

	Total amount	Beneficiaries	Burden bearers
EEG differential costs	approx. 4,700 mill. EUR	Plant operators	All electricity customers, except those benefiting from special compensation provision in EEG
Merit-order effect (RE power)	approx. 3,600–4,000 mill. EUR	Electricity customers or suppliers depending on cost transmission, probably power-intensive non-tariff customers in particular	Conventional power generators
Taxation of RE power	approx. 900–1,100 mill. EUR	Federal budget / state pension scheme	Electricity consumers, possibly RE power generators (direct marketing)
Federal subsidies for RE	approx. 450 mill. EUR	Plant operators, indirectly also manufacturers and others (innovation effects etc.)	Federal budget
Special compensation provision in EEG	approx. 700 mill. EUR	Approx. 500 power-intensive companies and railways	All other electricity consumers

Macroeconomic and other effects (selection)

Sales effect (RE overall)	approx. 31 bn EUR (total sales) or 15 bn EUR (directly relevant to employment)
Employment (RE overall)	At least 278,000 direct and indirect jobs
Energy imports avoided (RE overall)	6.6 bn EUR (net)
Energy price effect on GDP	100-200 mill. EUR
Impacts on internal and external security (incl. improved self-sufficiency in the energy sector)	n. q.

n.q. = not quantified

Selected key figures for the economic analysis of renewable energy expansion in Germany in the heat and power sectors in 2009

Systems analysis approach of cost and benefit aspects

Costs		Benefits	
Differential costs, electricity	5.6 bn EUR		
Basic/balancing energy	approx. 0.4 bn EUR		
Grid expansion	*0,03 bn EUR*		
Transaction costs	*0,03 bn EUR*		
Total, electricity	Approx. 6 bn EUR	5.7 bn EUR	Environmental damage avoided by renewable energy power (gross)
Differential costs, heat	1.5 bn EUR	2.1 bn EUR	Environmental damage avoided by renewable energy heat (gross)
		n.q.	Portfolio effects
Total[1)]	approx. 7.5 bn EUR	7.8 bn EUR	

[1)] Partly due to different base years, it is not yet possible to make a clear statement of the balance of the systems analysis of the costs and benefits for 2009 or to show the gross benefits.

Distributional effects

	Total amount	Beneficiaries	Burden bearers
EEG differential costs	approx. 4,700 mill. EUR	Plant operators	All electricity customers, except those benefiting from special compensation provision in EEG
Merit-order effect (RE power)	*approx. 3,600–4,000 mill. EUR*	Electricity customers or suppliers depending on cost transmission, probably power-intensive non-tariff customers in particular	Conventional power generators
Taxation of RE power	approx. 1,000–1,100 mill. EUR	Federal budget / state pension scheme	Electricity consumers, possibly RE power generators (direct marketing)
Federal subsidies for RE	approx. 800 mill. EUR	Plant operators, indirectly also manufacturers and others (innovation effects etc.)	Federal budget
Special compensation provision in EEG	600 - 700 mill. EUR	Approx. 500 power-intensive companies and railways	All other electricity consumers

Macroeconomic and other effects (selection)

Sales effect (RE overall)	approx. 33 bn EUR (total sales) or 16 bn EUR (directly relevant to employment)
Employment (RE overall)	At least 300,000 direct and indirect jobs
Energy imports avoided (RE overall)	5.1 bn EUR (net)
Energy price effect on GDP	*100-200 mill. EUR*
Impacts on internal and external security (incl. improved self-sufficiency in the energy sector)	n. q.

n.q. = not quantified
Italics in cases where data only available for 2008

3. Conclusion / Look ahead to further projects

The studies available to date show that the analysis on cost and benefits of renewable energy is extremely demanding in terms of methodological requirements. In view of the wide range of impacts identified, it is of central importance that quantitative comparisons are only possible within the individual effect categories described.

In spite of the frequent lack of data and the large number of methodological questions that are still unresolved, it is now possible to make a few basic statements:

1. The most important foundation for an overall economic assessment of renewable energy sources is in a first step a systems analysis approach for the analysis of costs and benefits in: Here a rough calculation of the existing quantitative system costs in the heat and power sectors reveals total costs of around EUR 7.5bn (6bn) for 2009 (2008). This compares with a quantified gross benefit for the same year of some EUR 8bn (also in 2008). Since, at present, the latter only comprises the cost of environmental damage avoided, more detailed studies are important here and are to be pursued in the near future. This can be expected to result in a reduction in the quoted (gross) benefit, as some of the damage costs are already included in the electricity costs, especially via the CO2 emissions trading system. It is nevertheless evident that any analysis of renewable energy expansion which argues solely on the basis of costs falls well short of the mark.

2. As far as distributional aspects are concerned, a complete registration and allocation of positive or negative charges to individual economic actors is not possible. Both in 2008 and 2009, electricity consumers were faced with a burden of around EUR 4.7bn as a result of the EEG surcharge. The merit-order effect of renewable energy sources, with its reducing impact on electricity prices, was only slightly lower in 2008. Since the extent to which this is passed on to the end consumer is not clear, it is not possible simply to compare the overall totals for the two effects. This would seem to be appropriate, however, for those companies that are covered by the special compensation provisions of the EEG. Their EEG surcharge is subject to crucial limits, and at the same time the majority of beneficiaries, as non-tariff customers, probably derive special benefit from the merit-order effects of renewable energy expansion which tend to reduce electricity prices. Thus, on balance, these companies will probably profit from renewable energy expansion. In view of the recent increase and expected substantial future rises in the EEG surcharge, an analysis of distributive effects is likely to be of special political relevance.

3. The macroeconomic parameters reflect the overall economic impacts of renewable energy expansion as a whole. Scientifically based gross figures are available for trends in sales and jobs as a result of renewable energy, though these may be offset

by negative effects. An earlier study[5] for the Federal Ministry for the Environment revealed clear positive net impacts on jobs in Germany in all realistic-looking scenarios; an updated version of the study will be available by the middle of this year. Another clearly positive macroeconomic impact of renewable energy expansion is the energy price effect on GDP, which in Germany was found to be about EUR 0.1-0.2bn.

There are certain significant benefits of renewable energy expansion that cannot be recorded in the above category, or only to a limited extent. This applies particularly to the contribution of renewables to energy supply security and the associated issue of strategic security policy aspects. Another aspect of importance when assessing subsidies for renewable energy is their long-term dynamic impact on innovation. One task for the years ahead is to undertake a more detailed scientific analysis and, if possible, quantification of these and other barely analysed effects. At the same time, the analysis of known effects also needs to be refined. In future, an overall view of the effects outlined will provide a sounder basis for economic statements about the arguments for renewable energy. In view of the unresolved questions indicated, however, there is no sign yet of a final unequivocal judgement about the overall economic costs and benefits of renewable energy expansion.

[5] ZSW/DLR/DIW/GWS: Wirkungen des Ausbaus der erneuerbaren Energien auf den deutschen Arbeitsmarkt unter besonderer Berücksichtigung des Außenhandels. Study commissioned by the Federal Environment Ministry (BMU). The report can be downloaded from http://www.erneuerbare-energien.de/inhalt/36860/40289/; the site also includes other BMU studies of the employment effects of renewable energy.

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