May 2001 ECN-C--01-030

RENEWABLE ENERGY BURDEN SHARING

REBUS

Effects of burden sharing and certificate trade on the renewable electricity market in Europe

Executive Summary

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EXECUTIVE SUMMARY

The creation of an internal market for renewable electricity in the EU will involve a political negotiation process on the (re-) distribution of targets and costs. This project concentrates on the development and use of the REBUS model. The REBUS model quantifies and analyses the effects of implementing RES-E targets, and the impact of introducing instruments to achieve burden sharing targets within the EU, such as a Tradable Green Certificate (TGC) system. With this, the REBUS model is a framework that can be used for determining the most equitable distribution of costs (burden sharing). Therewith it aims to support key policy makers, industrial stakeholders and consumers in making decisions on the possibilities to achieve their joint RES-E targets.

S.1 Objectives and research questions

The main project objectives of the REBUS project were to:
1. Support the EU and its Member States to achieve their renewable electricity targets for the year 2010.
2. Develop a framework for determining the most equitable distribution of costs.
3. Provide policy makers, industrial stakeholders and consumers with the guidance and guidelines by which to make decisions that reflect this equity.

To satisfy these objectives, the following key research questions were defined as the basis for the analysis in the REBUS project:
1. What are the achievable potentials and expected costs of renewable electricity in the EU Member States?
2. What are the costs of achieving EU targets for renewable electricity?
3. What are the effects of different burden sharing rules to achieving these targets?
4. What renewable electricity technologies will penetrate in the EU market?
5. What are the effects of other supporting policies on achieving the EU targets?

S.2 The REBUS model

The REBUS model quantifies the impact of trade in burden sharing mechanisms and the implementation of different rules to setting regional and (inter)national targets for the share of renewable electricity consumption or production. Results are obtained for a range of so-called burden sharing options that reflect differences in economic, social and geographical possibilities to increase the share of renewables in individual geographical regions. The REBUS model furthermore analyses the impact of other supporting mechanisms for renewable electricity on the effects of a burden sharing mechanism.

An important condition of renewable energy policy is often that the target is reached in a cost-effective way. An important means to achieve this cost effectiveness is to introduce the possibility of trading. In the REBUS model this is implemented by means of trade in green certificates, which in fact represent different ways of burden sharing. Countries can lower their overall costs of meeting the targets by importing certificates instead of realising (a part of) their domestic target, or (in case of abundant relatively cheap RES-E potentials) export certificates. The REBUS model allows for analysing the benefits of introducing such a trading scheme. Note that in the REBUS model it is assumed that trading occurs through the trading of green certificates, and not of the physical electricity itself.

The main questions that can be answered by the REBUS model include:

- What are the costs of realising (inter) national or regional targets for RES-E?
- What will be the expected price of tradable green certificates in the region?
- What are the cost benefits of interregional trade in tradable green certificates?
- What it the impact of applying different burden sharing rules to achieving RES-E targets?
- Which technologies are likely to penetrate in the coming years on the basis of cost-effectiveness?
- What is the effect of changes in the cost or potential of individual technologies on the penetration of this technology and on the resulting costs of achieving renewable electricity targets?
- What are the effects of other national or regional supporting policies on the certificate price and the costs of achieving targets?

S.3 Methodology

Definition of costs

The cost definitions used in this project have been established so as to make the costs comparable across countries. The investment costs that have been used are completely harmonised and the methodology for determining the non-harmonised costs was consistent across all countries covered in the work.

The harmonised costs assume the completion of a single internal EU electricity market and thus the fact that some cost factors, such as the costs of technology, fuel costs (excluding transportation) and discount rates should be assumed equal for all market actors in all Member States. Thereby the methodology assumes that in principle the investment costs for a certain technology are independent of the nationality or the nature of the investor. For instance, buying a Danish windmill is just as expensive for a Danish investor as for an Italian one. The costs of installation, operation and management of this windmill, however, vary across Member States. These costs are called the non-harmonised costs.

The non-harmonised costs are the variable costs of implementing a renewable energy project, such as installation, operation and management. All of these cost factors are by nature different across all countries.

Definition of renewable electricity potentials

To specify the potential penetration of renewable electricity in the year 2010, a step-wise approach is used for each renewable electricity source in which a broad scope of factors are incorporated that hamper the penetration of RES-E. The remaining barrier is of an economic nature: when the cost price of a certain technology (including subsidies or other measures) is not competitive, the technology will not penetrate into the electricity market.

For each source of renewable electricity the following potential definitions are specified:

- Theoretical potential: the total physical energy flow of that source.
- Technical potential: including technical constraints, such as the availability of potential sites or primary fuel streams (for biomass).
- Realistic potential: including non-technological factors, such as planning issues and acceptability problems.
- Realisable potential: including restrictions on the availability of technologies, such as maximum market growth rates for the production capacity of the RES-E industries.

EU cost curve for renewable electricity

The individual cost curves created for the EU Member States are added to construct the EU cost curve. To do so, all the bands for all the Member States are arranged according to cost price, cheapest first, and most expensive last. The cost price on the vertical axis is the total price, including the reference price on the EU internal electricity market. This reference price is set at 3 eurocent/kWh in 2010.

Based on the expected total consumption of electricity in the EU in 2010 (specified in the European Union Energy Outlook tot 2020) and the distribution of targets as included in the EU Draft Directive, the EU target equals 662 TWh.

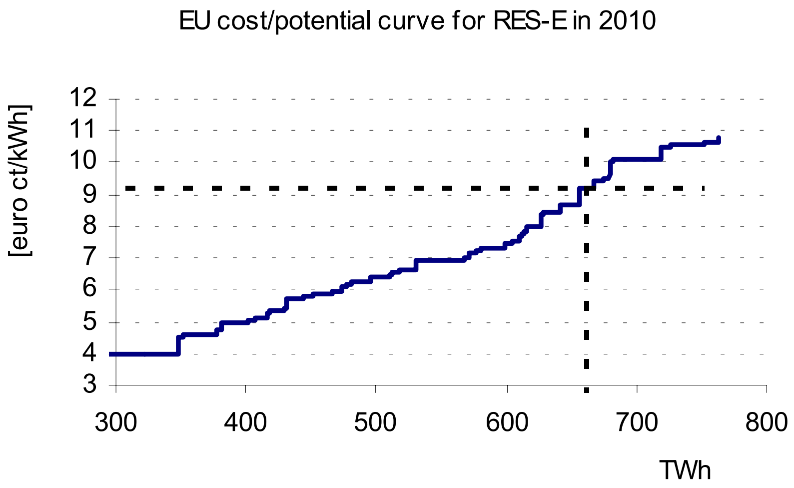


Figure S.1 *Final RES-E cost curve for the EU for 2010*

S.4 The costs of realising renewable electricity targets in the EU

The EU curve can be used to determine the total costs of meeting the targets as proposed in the EU Draft Directive. Referring to Figure S.1, these total costs are given by the area enclosed by the fixed demand curve of 662 TWh and the EU cost potential curve. The total costs are equal to 17.6 billion euro. Figure S.2 shows the division of costs across Member States in cases without trade and with trade. The highest profits resulting from trade are expected on the one hand in countries with relatively large RES-E potentials such as Denmark and Finland, and on the other hand in countries with relatively low RES-E potentials (Belgium) or where most cost-effective locations have already been used (Germany and Spain).

Obviously the commercial market parties operating in this renewable electricity market will not sell their certificates at cost price, but at the certificate price of 9.2 eurocent/kWh (see below). Therefore, the total expenses are given by the area enclosed by the vertical demand line, the horizontal line of the reference power price of 3.0 eurocent/kWh, and the horizontal line of the green certificate price of 9.2 eurocent/kWh. These costs add up to 41 billion euro.

S.5 The expected price of tradable green certificates in the EU

The certificate price on the EU market is given by the last option needed to meet the EU target of 662 TWh. Graphically, this is given by the intersection of the fixed demand curve of 662 TWh and the supply curve for renewable electricity. Figure S.1 shows that the cost price of the last option required is 9.2 eurocent/kWh. With an assumed reference power price of 3 eurocent/kWh, the green certificate price equals 6.2 eurocent/kWh. In other words, every produced RES-E kWh will be sold at the sum of the market price of 3 eurocent and the certificate price of 6.2 eurocent.

S.6 Cost benefits of international trade

When an international trading system is implemented, RES-E is produced at the locations where it is most cost-effective. Therefore, a trading scheme considerably reduces the costs of achieving the overall EU target of RES-E. Calculations with the REBUS model show that implementation of a European trading system could reduce the costs of achieving the RES-E targets of the Draft Directive by 15%. Figure S.2 shows that large differences exist in the cost savings resulting from trade between individual Member States. Countries that have relatively low potentials (Belgium; saving 40%), relatively high target (Spain; saving 21%) or a high target in absolute levels (Germany; saving 19%) gain most. Countries that have negotiated a relatively weak target or have high RES-E potentials gain less.

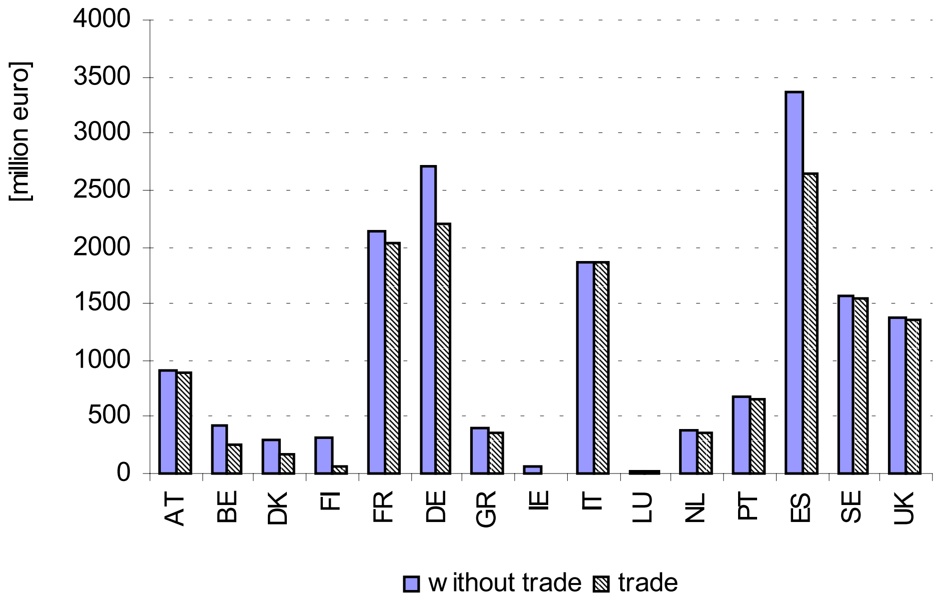


Figure S.2 *Costs of achieving national targets from the Draft Directive, without and with an EU trading scheme*

When an international trading system or burden sharing scheme is implemented, RES-E is produced at the locations where it is most cost-effective. This means that Member States with a relatively high or cost-efficient potential, such as Finland, France, Denmark, Ireland and Greece, produce substantially more than required for their own target. Table S.1 lists the differences between the targets and the actual deployment in each of the EU Member States. For the targets as proposed in the Draft Directive, the total trade volume of 41.5 TWh corresponds to 6.3% of total production in the EU of 662.1 TWh.

Table S.1 *Deployment of RES-E by country in 2010 with a trading system implemented, for the target division proposed in the EU Draft Directive in [TWh]*

	Target (Draft Directive)	Actual deployment
Austria	55.2	53.6
Belgium	6.3	4.6
Denmark	12.9	18.5
Finland	30.2	42.1
France	112.9	119.6
Germany	76.7	65.6
Greece	14.6	18.5
Ireland	4.5	10.2
Italy	89.8	91.2
Luxembourg	0.5	0.5
Netherlands	11.9	10.6
Portugal	24.2	21.4
Spain	75.2	51.3
Sweden	97.5	100.9
United Kingdom	50.0	53.6

The Nordic countries all are regarded as potential exporters of certificates, as a result of the relatively large and low-cost potentials. Greece and Ireland also have significantly higher low-cost potentials than required to meet the targets assigned. France, Italy and the United Kingdom complete the group of exporting countries. Cost-effective deployment opportunities in Spain and Germany are considered inadequate to meet their national RES-E targets. This is of course largely influenced by the assumption of no additional supporting policies.

S.7 Effects of applying different burden sharing rules

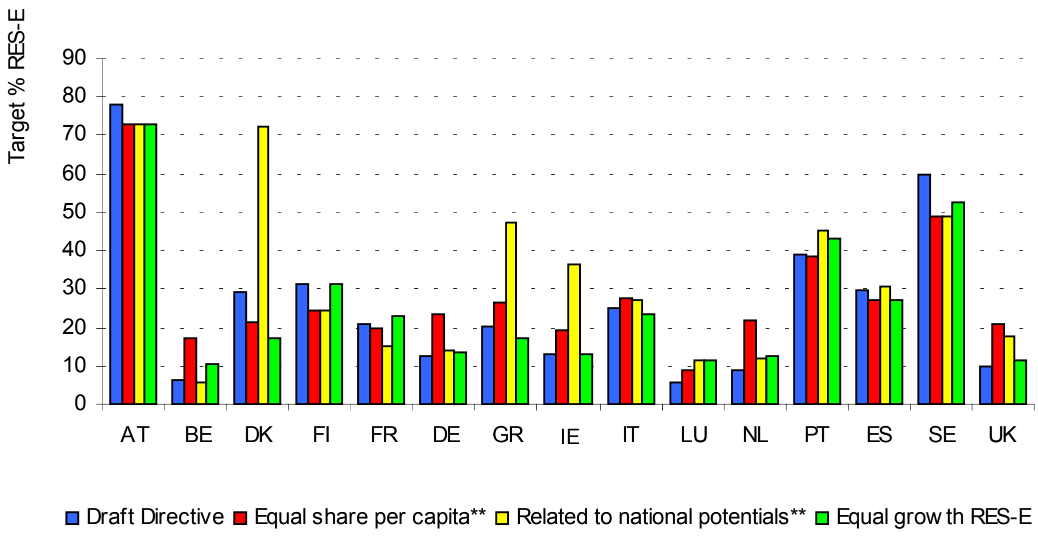
The interpretation of fairness in distributing the targets over the individual Member States largely affects the resulting individual targets and the corresponding costs to achieve these targets. The targets agreed in the Draft Directive result from a political negotiation process in which policy makers have weighted a set of policy objectives. The REBUS model has been used to calculate the effects of alternative target setting and burden sharing options.

Figures S.3 and S.4 picture the resulting distribution of national targets in a number of cases. Figure S.3 includes three alternative target options and the target distribution as specified in the Draft Directive. These alternative target options are:

1. Related to potential: the individual targets are set according to the total potential of RES-E in the country.
2. Equal share per capita: equal share of RES-E consumption per capita in the year 2010.
3. Equal growth RES-E: equal growth rates of RES-E consumption in the period 1995-2010.

Figure S.4 pictures two so-called burden sharing options, compared to the target distribution in the Draft Directive. The alternative burden sharing options included in are:

1. Equal costs per GDP: total costs to achieve the EU target are divided over the EU Member States according to the Gross Domestic Product of each Member State.
2. Equal costs per capita: total costs to achieve the EU target are divided over the EU Member States according to the population of each Member State.



** To the underlying targets, corrections have been applied as explained in Table B.3 in Annex B.

Figure S.3 *Resulting distribution of national targets in four calculated target options*

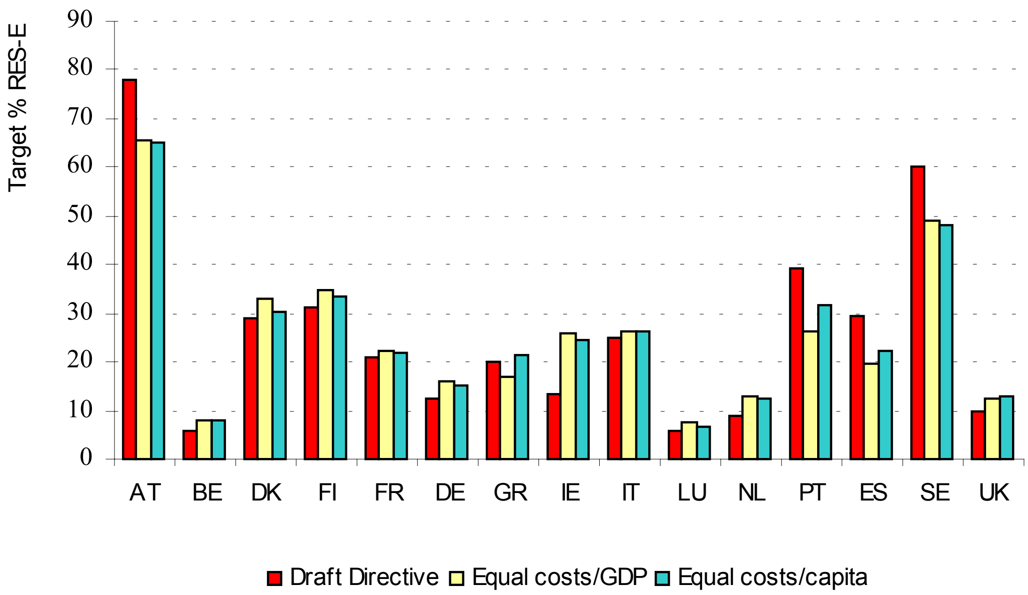


Figure S.4 *Resulting distribution of national targets in calculated burden sharing options*

As could be expected, the choice of target setting criteria largely influences the resulting distribution of targets. For a number of countries, the national targets as agreed in the Draft Directive are significantly lower than the calculated national targets based on other target setting criteria. This concerns the Netherlands, Luxembourg, Belgium, Ireland, Belgium and the UK.

The targets negotiated for Finland, Sweden and Austria are quite ambitious: the resulting national targets in the Draft Directive are higher than for all other target sharing options calculated. When other criteria such as equal shares per capita or equal growth in renewables are used, the targets would be reduced up to one-fifth of the current target.
The targets set for Austria, Sweden, Portugal and Spain would be significantly lower when economic welfare or population would be taken into account. Targets for most other countries would increase in those cases, with Ireland and Belgium as frontrunners.

S.8 Penetration of RES-E technologies

If a standard tradable trading system without specific technology distinctions would be the only mechanism used to support RES-E, it is evident that only the cheapest technologies available would penetrate. Technologies with a marginal cost price well below the certificate price may benefit the most from the international trading system whereas RES-E technologies close to the marginal costs may have difficulties in accumulating capital for further technology development. Figure S.5 pictures the technology mix of additional RES-E deployments required to achieve the EU targets as specified in the Draft Directive in case a trading scheme is implemented. 'Deep green' biomass includes forest residues, energy crops, agricultural waste and geothermal electricity. 'Light green' biomass includes liquid wastes (for biogas), clean solid wastes, industrial wastes, farm slurries, sewage sludge and landfill gas. MSW means municipal solid waste.

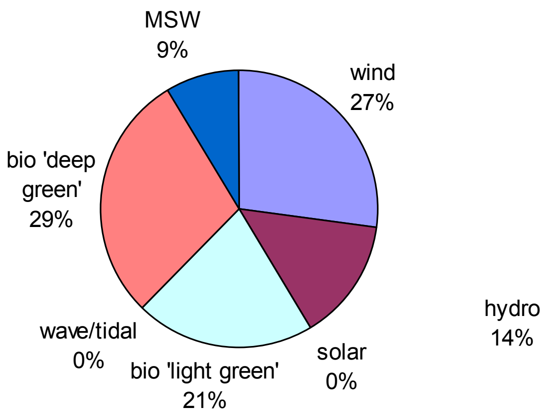


Figure S.6 *Technology mix of additional RES-E deployments*

The results are largely affected by the restriction on the maximum growth rate of the European wind production industry. This limits the total capacity of wind power (onshore and offshore) in the year 2010 to 60 GW. If this restriction were not implemented, the price of certificates would drop from 6.2 to 4.8 eurocent/kWh, with total costs of 13.43 billion euro. Obviously, the large amount of wind power production cannot be achieved if circumstances are not drastically changed. Political, economical and technical measures should be taken to realise a further growth in wind power production capacity.

RES-E technologies at an early stage of development will not be able to benefit from the trading scheme outlined. A number of these non-penetrating technologies, however, are expected to include very important future potentials, required to achieve long-term targets. Photovoltaic is one such technology. Therefore, policy makers, industry representatives and other parties involved often argue that additional support should be provided for further development of these long-term promising RES-E technologies. To illustrate the effects of such additional support, the REBUS model was used to analyse additional support for PV. Results show that the support of seven eurocent/kWh is the minimum support needed to see any penetration of PV. In that case, only the potential included in the cheapest band in Portugal penetrates on the market: 116

GWh. If the additional support is raised to ten eurocent, the full potential for Portugal (349 GWh) and the cheapest potential in Greece (111 GWh) becomes cost-effective. In all other countries the additional support of 10 eurocent/kWh is still not enough to see PV entering the market.

S.9 Excluding waste or large hydro

Policy makers, the energy sector itself, NGOs and other stakeholders still debate whether new large hydro and/or waste options should be included in an EU scheme to achieve RES-E targets. Obviously, excluding these technologies from the RES-E market will affect the overall costs of achieving targets and the distribution of RES-E deployment and costs over Member States. The REBUS model was used to analyse the main consequences of excluding RES-E technology based on municipal solid waste and new large hydropower plants from a European trading system. The results are summarised in Table S.2. The impact of excluding new large hydro power has an equally large effect as excluding MSW and other waste.

Table S.2 *Effects of excluding certain technologies from EU trading scheme*

Excluded from the EU trading scheme	Certificate price [eurocent/kWh]	Total costs after trade [billion euro]
None	6.2	14.34
Municipal solid waste	8.1	15.38
MSW and other waste	9.2	15.65
New large hydro power	9.2	15.80

S.10 Interaction of EU trading scheme with supporting policies

The implementation of a burden sharing system in the EU in principle respects the subsidiarity principle since each individual Member State is free to define its own national implementation of this system and its own set of additional supporting mechanisms. However, different interpretations between Member States and different systems can affect the implementability and the success of any EU burden sharing mechanism. Representatives from utilities and consumer organisations interviewed for this project strongly advocate that there should not be any interference between different systems that support renewables. Their main arguments are that certificates should be based on similar definitions and implementations, and that national support mechanisms could result in transfer of taxpayers' money abroad.

Two cases were analysed with the REBUS model.

1. *The interaction of an EU trading scheme and the Dutch energy tax.* Renewable electricity supply in the Netherlands is exempted from the Dutch energy tax. The total support for RES-E resulting from the bill equals 7.77 eurocent/kWh. With a maximum amount of exempted RES-E of 30 TWh, the total costs for the Dutch government could be up to 2.3 billion euro.
2. *Effects of German and Spanish feed-in tariffs.* Continued use of a feed-in tariff in Germany and Spain of 1.6 eurocent/kWh would increase cost-effective onshore wind potentials. In Germany, the assumed tariff results in approx. 4200 GWh additional production penetrating on the EU market, and thus lowers the German potential import of certificates. The total costs of this additional support for Germany equals 0.7 billion Euro. In Spain, the additional feed-in tariff should at least be equal to 2.2 eurocent/kWh to significantly affect the cost-effective penetration of Spanish wind power. A total of 6973 GWh could then be supported, resulting in total additional costs of 1.5 billion Euro. Additional penetration of wind offshore is limited, since cheaper potentials exist elsewhere in Europe (e.g. Denmark) and the overall yearly growth factor for the total wind offshore industry in the EU is assumed to be limited to 30%.