Analyse & Kritik 01/2010 (© Lucius & Lucius, Stuttgart) S. 159–176

Till Requate

Climate Policy between Activism and Rationalism*

Abstract: This article discusses German and European climate policy, inquiring mainly whether the ambitious goals the EU has set itself can be achieved via the instruments presently employed for the purpose and whether these instruments are efficient. In particular we discuss shortcomings of the European emission trading system, we further level criticism at energy policy measures, notably subsidization for renewable energy sources and the overlap with emissions trading. Further we argue that while 20% reduction of CO_2 is feasible at a reasonable cost, derived targets such as a share of 20% of renewable energy and 20% efficiency increase is expensive and not necessary. Finally, we scrutinize the latest climate-protection package proposed by Germany's environment minister.

1. Introduction

With its '3 x 20' program the European Union has set itself ambitious energy-policy goals. '3 x 20' means that by 2020 CO_2emissions are to be reduced by 20% relative to 1990, the share of renewable energies in overall energy consumption is to be increased to 20%, and the energy efficiency in the combustion of coal, oil, and gas is to be upped by 20%. By 2030 the aim is to reduce emissions by 30% and by as much as 60–80% if other industrial countries cooperate.

In this article I discuss whether these goals are realistic, whether they make sense, and what they are likely to cost. In particular, I shall be inquiring into the viability of the much-vaunted energy project undertaken by the last German government, the Renewable Energy Sources Act (EEG). My main contentions in the following are that subsidization of renewable energies is incompatible with emissions trading, that the differentiation of subsidy rates is inefficient, and that the subsidization of certain forms of renewable energy production does not stand up to a cost-benefit analysis.

The article is organized as follows: The next section examines the crucial findings set out in the Stern Review, notably assessment of the cost of abating greenhouse gases. *Section 3* is a discussion of the way in which markets can fail. *In section 4* I describe what the ideal case of environmental policy regulation would look like. *Section 5* deals with the inadequacies of the present emissions

* I am grateful to an anonymous referee and to the editor Friedrich Breyer for reading the manuscript carefully and making valuable suggestions to improve the paper.

trading system. *Section 6* is a critical review of German and European policies aiming at the subsidization of renewable energies. In *section 7* I discuss the latest EU resolutions for the reduction of CO_2 emissions and in *section 8* the concomitant measures planned by the German Federal government at the national level. *Section 9* summarizes my thoughts on the subjects discussed.

2. The Crucial Findings of the Stern Review and the Fourth IPCC Report[1]

In 2006 a group of experts headed by the British economist Nicholas Stern attempted to put a figure to the future economic damage caused by global warming and to compare this figure with the costs of abatement.[2] Stern and his colleagues estimated that if economic activity goes on as it has so far, the future economic costs would be equivalent to between 5% and 20% of world GDP at present. The wide-ranging scope of this estimate is attributable to the equally wide range of assessments pertaining to the rise of the average temperature on the surface of the earth caused by CO_2 radiative forcing and its regional distribution. According to the fourth IPCC Report, stabilization of CO_2 concentration at 450–550 ppm (parts per million) would require a global reduction of present-day CO_2 emissions by 25%.[3] For reasons of fair distribution the Stern Review recommends that the major industrial countries should shoulder the major burden involved and curb their emissions by 60% to 80% by 2050. A crucial question in this connection is how much it would cost to achieve this goal. The answer depends to a very large degree on the government measures taken. The Stern Review suggests that efficient allocation (i.e. equalization of the so-called marginal abatement costs[4] across all sectors and all countries)[5] would mean that not much more than 1% of annual global GDP would need to be sacrificed. Germany's largest economic research institute, the German Institute of Economic Research *(DIW)*,[6] estimates that Germany would need to expend some 0.33% of its GDP to make a fair contribution to lowering European emissions by 20%. Less efficient allocation would however cause this figure to rise to between 0.85% and 0.95% of the German GDP. These figures show that allocation efficiency is extremely important to make ambitious CO_2 reductions feasible at all.

3. Where Do Markets Fail?

To indicate the purpose and necessity of governmental interventions in the economic process, it makes good sense to spend a little time discussing the circumstances under which markets may fail. Let us begin by asking when markets

[1] IPCC = Intergovernmental Panel on Climate Change.
[2] See Stern 2006.
[3] See Parry et al. 2007.
[4] Marginal abatement costs are the costs incurred in abating the last ton of CO_2.
[5] This rule is explained in section 3.
[6] See Kemfert et al. 2007.

function well for the good of all. The so-called First Theorem of Welfare Economics provides an answer. If all firms are relatively small and have no appreciable influence on market prices, if there is sufficient information in all markets about prices, quantities, and qualities, and if, last but not least, no agent imposes any externality on another agent, then the play of market forces will lead to optimal welfare.

Economists express this idea by saying that a competitive market equilibrium[7] is Pareto-efficient.[8] But ideal preconditions for this theorem are not always given. Not all companies are small. Some of them have market power and can indeed have an influence on prices. Secondly, information deficits prevail in certain markets, and (thirdly) external effects do occur in the production of certain goods. External effects are actions influencing other economic agents (households or companies) in a positive or negative way where no compensation for those effects is paid. Examples of negative external effects are impairments from pollution and strain on the environment. Examples of positive external effects are the beauty of historical buildings or the education level of the population.

If optimal allocations are thwarted by these three eventualities (market power, information deficits, external effects), economists refer to this as market failure. Such failure can be countered in various ways. The job of the cartel authorities, for example, is to regulate excessive market power. Environmental policy, for its part, sets out to 'internalize' external effects. This does not mean that external effects have to be eliminated altogether, merely reduced (or raised) to a best-possible level. In the case of market failure caused by imperfect information, the state can also assist on occasion, e.g. by supporting consumer-safety organizations like Germany's *Stiftung Warentest*. But particularly in cases of asymmetric information the state is frequently unable to intervene because in many instances its knowledge is as imperfect as that of the individual economic agents.

4. The Ideal Case of Regulation via Environmental Policy

To get a better idea of the efficiency or inefficiency of certain political measures, let us first of all look at ideal-type regulation in its simplest form. For this purpose we consider a number n of sources of a homogeneous pollutant, each emitting quantities of that pollutant amounting to e_i. Total emissions of this pollutant are then given by $E = \sum_{i=1}^{n} e_i$. We assume that the damage depends entirely on the sum of the emissions and is quantified by a monetarized damage function $D(E)$ converting the damage caused by emissions into monetary

[7] A competitive market equilibrium is an allocation of goods quantities and production factors that best satisfies the needs of consumers under the given prices and budget, maximizes firms' profits, and represents a state of affairs in which supply and demand equal one another in all markets.

[8] An allocation is Pareto-efficient if it is impossible to make one person better off without making at least one other person worse off.

units.[9] Suppose this damage function is increasing and (weakly) convex in E. This means that the marginal damage (the damage caused by the last unit of pollutant) will increase (or at least not decrease) if a higher degree of pollutant emissions occurs. But the reduction or abatement of pollutants by the emitters will itself incur costs. So let $AC_i(e_i)$ express the opportunity costs caused by abatement on the part of emitter i, if i restricts his pollutant emission to e_i units. These costs may either be the costs of acquiring and operating abatement technologies or quite simply costs caused by adjusting (reducing) output and hence losing out on the profit side. Let the abatement cost functions of the individual emitters be decreasing and convex ine_i. In other words, the costs will rise disproportionately, the more the emitter does to restrict his pollutant emissions. The overall social costs are then the sum of the abatement costs plus the societal damage caused by the sum of the pollutants emitted. Put in a formula this can be expressed as follows:

$$SC = \sum_{i=1}^{n} AC_i(e_i) + D(E)$$

If a fictitious social planer minimized these overall social costs in terms of the output of emissions by the individual emitters and the total pollution level E, we would obtain two important efficiency conditions: First, the marginal cost[10] of abating one more unit at polluting source 1 should be as large as the marginal cost of abating one more unit at polluting source 2. In other words, it should be equally expensive at any source of pollution to reduce a further unit. If this were not the case, but it would cost 10€ to reduce the last unit at source 1, but 20€ to reduce the last unit at source 2, the whole economy could save costs, by letting polluter 2 reduce one unit less and polluter 1 to reduce one unit more, so that the total pollution levels stays the same.

The second efficiency condition requires that the marginal cost of abatement is equal to the marginal damage caused by the pollution. Note that the marginal damage of pollution can also be interpreted as the society's marginal willingness to pay for reducing pollution by a further unit. This rule 'marginal abatement cost equals marginal damage' is intuitive: if the rule is satisfied, society's willingness to pay for further pollution reduction is exactly as large as it costs to reduce pollution by a further unit.

The two efficiency conditions are illustrated in Figure 1 for the case of two emitters. The figure also shows the aggregate marginal abatement cost curve deriving from horizontal aggregation of the individual marginal abatement costs.[11] Note that in the social optimum the aggregate marginal abatement cost curve

[9] In many cases monetarized damage can also be interpreted as the willingness of those affected to pay for prevention of the damage.

[10] The concept of marginal cost is crucial in economics. The marginal cost of abatement is the additional cost of abating one more unit. Marginal abatement costs are not constant in general, but depend on the level of abatement (or the pollution level), that has already been achieved.

[11] Aggregating means 'adding up'. In case of marginal abatement cost, all emissions that have the same individual marginal abatement costs are added up to achieve the aggregate marginal abatement cost curve.

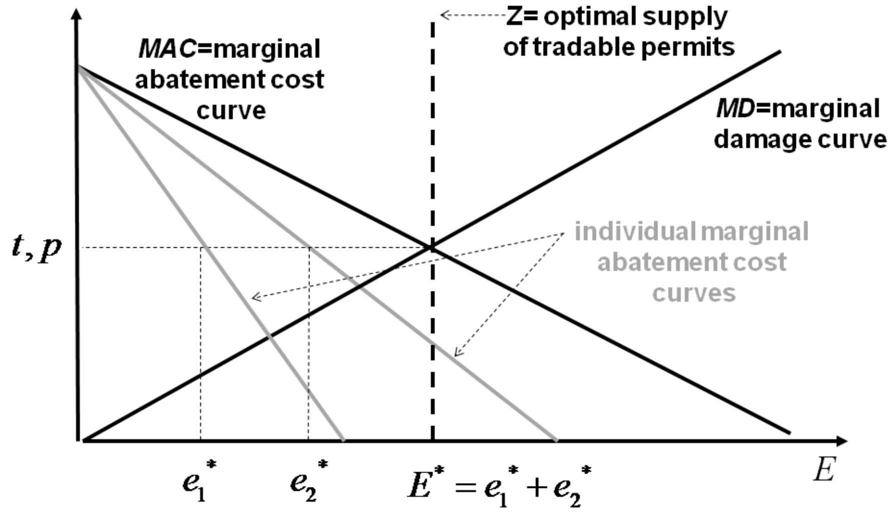

Figure 1: Allocative efficiency with the example of two polluters, t and p denote a tax rate or a permit price, respectively.

also intersects with the marginal social damage curve. Accordingly, we can simplify the optimality rule and express it as 'social marginal damage equals social marginal abatement costs'.

So how can efficient allocation be achieved by regulation and decentralized decision-making? The first possibility is to impose on the emitters a tax equivalent to the marginal damage for each unit of pollutant emitted, also indicated in Figure 1. If the companies behave in a cost-minimizing way, they will abate their emissions precisely to the extent that will make their marginal abatement costs equal to the tax rate.[12] If the government makes the tax equivalent to socially optimal marginal damage (at the intersection of the aggregate marginal abatement cost curve and the marginal damage curve), the socially optimal allocation will result automatically from decentralized decisions (see Figure 1).

Instead of establishing a price for emissions administratively, the government can also stipulate the maximum amount of emissions and leave it to the market to allocate these efficiently to the emitters. This is where the idea of emission trading comes in. Either the government auctions off the number of emission certificates it considers optimal, or it distributes them to the emitters free of charge. Then the latter can efficiently redistribute the emission certificates. If all emitters are relatively small and thus will not be able to influence the market

[12] The reason is that as long as marginal abatement costs are lower than the tax rate, it is profitable for a polluting company to further reduce emissions instead of paying a tax for those emitted units. If, by contrast the marginal abatement costs exceed the tax rate, a firm can save costs by not reducing those units, but rather pay the tax.

price for certificates, then the effect of such a price is no different from that of a tax. Firms will abate emissions to the degree where the marginal abatement costs are precisely equivalent to the market price of emission certificates. If the government has issued precisely the number Z of certificates that corresponds to the optimal incidence of emissions, i.e. $Z = E^{opt}$, then the market price for emissions must in its turn be equivalent to optimal marginal damage. Here again the social optimum will be achieved in a decentralized way. This state of affairs is also shown in Figure 1.

As we have seen, price and quantity instruments are equivalent, provided the regulating bodies know all there is to know about the relevant factors and functions involved. In reality, of course, the regulating authorities do not have perfect knowledge of the factors involved, notably the emitters' abatement costs. Theoretically it is possible to demonstrate (Weitzman 1974) that in the case of imperfect information on abatement costs and a relatively steep marginal damage curve, a certificates policy (i.e. one that dictates the quantity of emissions) will lead to less expected welfare loss than an emissions tax. The point here is that a very steep marginal damage curve implies that fluctuations in emission quantity may lead to very considerable damage, so that it is essential to impose a restriction on quantity. But if the marginal damage curve is relatively flat in comparison with the marginal abatement costs, then the opposite will be the case. In the case of an economic boom, fluctuations in the demand for certificates caused, say, by cyclical fluctuations, may generate a steep increase in industrial abatement costs as a result of strong rises in certificate prices. With an emissions tax such cost increases would be far less dramatic. In the presence of a relatively flat damage function, on the other hand, the additional environmental damage caused by additional emissions would be relatively slight. In this case expected welfare loss would be lower with a tax than it would be with certificates.

Of course, taxes and certificates will only be efficient if they are consistently implemented by the authorities and not distorted or diluted by exemptions. Particularly in connection with free allocation, the potential for error is considerable. For example, one question that poses itself is whether certificates should be allocated free of charge in all cases, notably in the case of new market entrants or capacity extensions. Another moot point is what should be done with certificates that a company no longer requires after closing down one of its sites. Would it have to return them to the state, or could it sell them on the market? From an allocation viewpoint these questions can be answered quite categorically. All companies entering the market for the first time or extending their capacities should have to acquire all (additional) certificates required from the market. In both cases, free allocation would be equivalent to a subsidy leading to excessive market entry. Secondly, companies leaving the market should not be dispossessed of their certificates, as this might artificially delay company closure if the market value of the certificates is high.[13,14]

[13] On this point see Graichen and Requate 2004.

[14] On the American market for SO_2 emission certificates this regulation has indeed been implemented in a way that is fully in line with economic theory. Companies (or their legal successors) that have benefited from free allocation of certificates are granted them for a further

Matters are more complicated with respect to dynamic incentives for firms to develop and adopt new technology. Here a permit regime can provide too little incentives to invest, since investment of some firms induces lower prices on the permit market which in turn provides less incentives for other firms to also invest.[15] This problem can be solved, however, if the government implements a flexible permit system: The government could auction off a flexible number of permits and set a minimum price. This would imply that the government is ready to buy back a certain amount of permits if the permit price falls below a certain threshold.[16]

5. The Shortcomings of the European Emission Trading System

As is only to be expected, the practical implementation of emission trading theory is still imperfect. One problem is that there is an imbalance between the sectors forced to participate in emission trading (ETS sectors,[17] notably energy producers, the cement, brick, and ceramics sector, and paper and cardboard manufacturers) and those either excluded from trading or no longer affected by compulsory participation (non-ETS sectors, above all transport and private households, which are regulated differently). As we have seen in section 4, allocation efficiency requires equalization of marginal abatement costs among all emitters and hence across all sectors. Accordingly, in terms of marginal abatement costs there is a major gap between ETS and non-ETS sectors. Calculations by the Kiel Institute for World Economy indicate that marginal abatement costs in the non-trading sectors are eight to ten times as high as in the trading sectors.[18] The EU directive on emission trading stipulates that every country has to say how it intends to fulfill its self-imposed Kyoto commitment, notably what measures it intends to take to ensure CO_2 reduction in the non-ETS sectors.[19] If sectors where the reduction of emissions is comparatively cheap are allowed to emit more CO_2, this will disadvantage other sectors where it is comparatively expensive to reduce CO_2 emissions, and the overall economic abatement costs are bound to rise accordingly.

Figure 2 shows the discrepancy between the Kyoto targets of the various EU countries and their actual emissions. We see from this that in Germany the target and the actual situation are quite close to one another due to the reduction of economic activity in what was once the GDR and that the United Kingdom is at present overachieving the target. By contrast, countries like Belgium, the

---

thirty years after close-down of an operating unit, whereas market newcomers have to acquire all the certificates required from the market.

[15] See Requate/Unold 2003.

[16] Requate/Unold 2001 suggest a system with options to buy additional permits or sell spare permits.

[17] ETS = Emission Trading System.

[18] See Klepper/Peterson 2006.

[19] See European Union 2003.

Netherlands, Austria, Italy, Spain, and (surprisingly, in view of its high share of wind power) Denmark are still well off track in terms of the Kyoto targets.

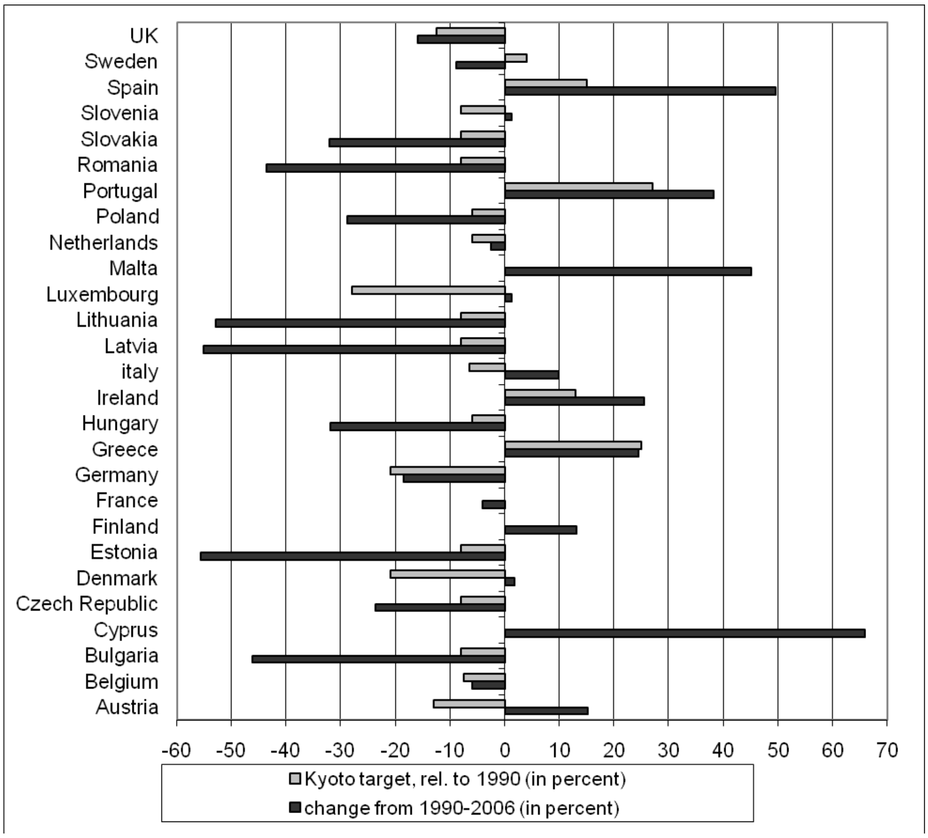

Figure 2: Grey bars: planned Kyoto reductions relative to 1990 in percent; black bars: actual reductions up to 2006; source: European Environment Agency 2008.

Figure 3 provides a partial explanation for these discrepancies. Here we see the percentage of reductions to be achieved via emissions trading, CDM projects,[20] and other national measures. For example, the German allocation plan sets out to achieve only 20% of emission reductions in the sectors obliged to engage in emissions trading, although over 40% of the emissions come from these sectors and the marginal abatement costs are lower there than in the other sectors where an 80% cut down on emissions is planned. Finland, Portugal, and above all Italy even allow for increased emissions in the ETS sectors over and against the 1990 figures. Here the substantial reductions envisaged are to be achieved in the other sectors. If we compare these targets with the discrepancy between overall

[20] CDM = Clean Development Mechanism. CDM projects are projects leading to emissions reductions in developing countries. EU companies can claim credits for such reductions at home and have them converted into emissions certificates.

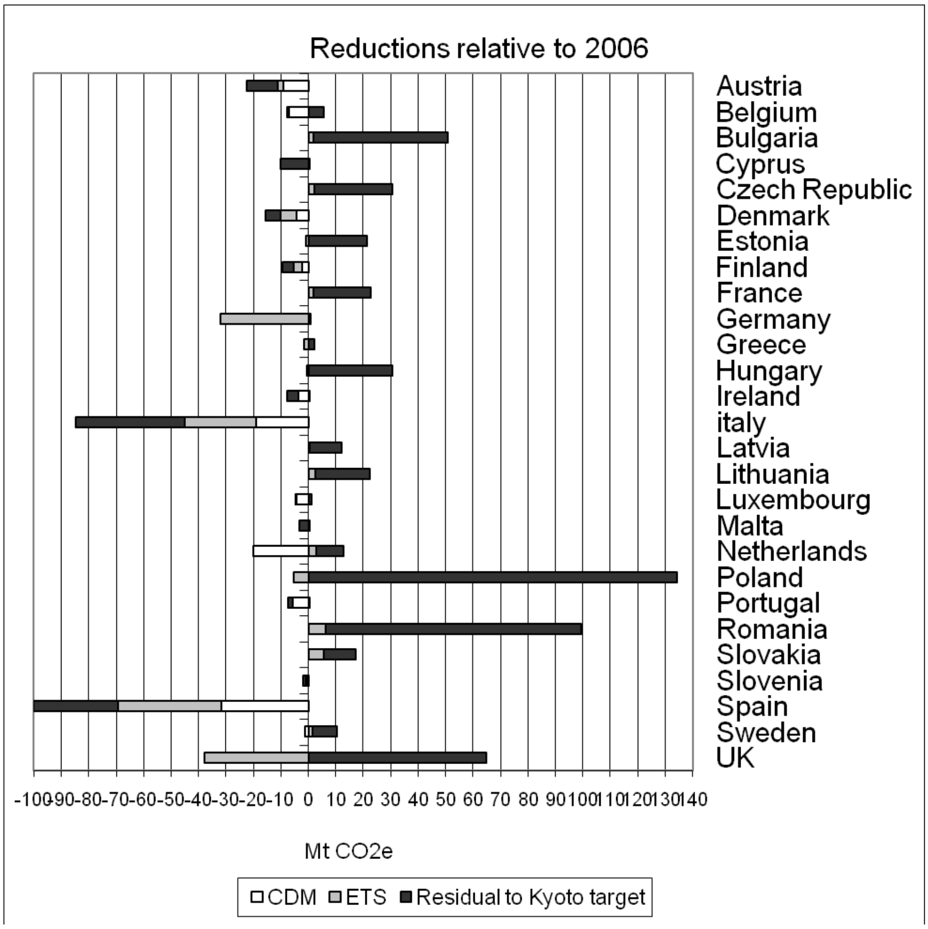

Figure 3: Planned Kyoto reductions by sector; grey bars: in the ETS sector, white bars via CDM; black bars: in the non-ETS sector (percentages relative to 1990).

reduction targets and actual emissions in Figure 2, it seems highly unlikely that Italy will be able to honor the commitments it entered into by ratifying the Kyoto Protocol. Much the same applies to Spain, Portugal, and Ireland. A major weakness of the EU policy is that it provides no incentives to cut down emissions in the non-ETS sectors and that no sanctions are envisaged if this does not happen. One way out of this dilemma might be to include the major non-ETS sectors in emissions trading. In transport and private households CO_2 emission is largely determined by fuel use. Accordingly, inclusion of these sectors could take place via the fuel wholesalers, who could be forced to hold a certificate for each unit of fuel producing a ton of CO_2 through combustion. Of course, inclusion of the relevant sectors in emissions trading would involve an increase in fuel prices, as the costs for emission certificates would be tacked on to the fuel prices. But here excessively high fuel prices could be avoided by scrapping green taxes and reducing mineral oil taxes. The resulting revenue gap could then be offset by auctioning certificates.

At the same time, increased demand for emission certificates can be expected to increase the prices for them. But these higher prices would lead to greater abatement efforts in the present ETS sectors. Alternatively, one might do without emissions trading and impose a uniform CO_2 tax on all CO_2 emissions. A policy change of this kind is however highly unlikely now since major efforts have been made to get emissions trading off the ground and the Obama administration is contemplating the introduction of CO_2 emissions trading in the USA.

As set out above, inequitable distribution of reduction burdens between ETS and non-ETS sectors (provided the reductions are carried out as planned) induces higher overall economic costs than are necessary to achieve the emissions target envisaged. The Kiel Institute for World Economy estimates short-term welfare losses of 0.7% of the GDP if abatement efforts are efficiently allocated. Under National Allocation Plan I[21] they would be almost four times higher (2.5% of GDP).[22] These discrepancies stem mainly from the imbalance between ETS and non-ETS sectors. Further distortions are caused by the unfortunate allocation and trading rules on emission certificates in the ETS sectors, for example free allocation for new entrants and generous allocation of permits to CO_2 intensive sectors.

Another drawback of the present emissions trading system is its lack of intertemporal flexibility. For example, the system prohibits companies from saving 'surplus' certificates from a given year, or even from the first trading phase, for use in the future (or in the second trading period). After the emission certificates had exceeded the 30€ mark in 2006, the price fell temporarily almost to zero in 2007. But in 2007 futures markets for the second trading period already featured prices of over 20€, and in 2008 and 2009 the price in most cases was back up to between 12€ and 20€. So there was a surplus of certificates in 2007, although they were scarce again in 2008. Accordingly, it would have made good sense to save up 2007 certificates for 2008 or later. This would have done the climate no harm. On the contrary, the later a ton of CO_2 is emitted, the later the effects on the climate will emerge. The technical term for this saving activity is 'banking', but major restrictions are imposed on it within the individual trading phases. Certificates from one year can only be used in the first quarter of the following year. The argument brought forward against banking was that it might prevent the Kyoto commitments from being honored between 2008 and 2012. But this argument is unconvincing, as the target might have been over-fulfilled in 2007

[21] National allocation plan I (NAP I) determines the allocation of emission reductions for the first phase of emission trading, i.e. 2005–2007.

[22] See Klepper/Peterson 2006.

and, as mentioned earlier, a delay in the emission of CO_2 would have done no damage to the global climate.

6. Promoting Renewable Energies

I now come to the favorite environment policy project of the former SPD/Green German government and still a showcase project of the current German government: the promotion of renewable energies. The Law on the Promotion of Renewable Energies (EEG) provides for differentiated, fixed rates of remuneration for the infeed of power stemming from wind-power plants, photovoltaic energy, power-heat cogeneration, and biomass combustion. This remuneration is paid initially by the mains operators receiving power from these sources. As the conditions for wind power plants are more favourable in the north of Germany than in the south, there are equalization payments between the mains operator so that all energy concerns contribute to the financial burdens imposed by feed-in remuneration in proportion to their share of the energy market. As the energy companies have to pay a great deal more for this power than they would if they produced it themselves, they pass on the additional costs to the consumers. The amount of feed-in remuneration is geared to the efficiency of production, in line with the rule 'the more inefficient you are in producing electricity, the higher your subsidies will be'. Accordingly, operators of land wind-power plants receive 5.5–8.7 cents per kilowatt hour, depending on location (operators at less favorable locations get higher remuneration), while the feed-in rate for offshore plants is 15 cents. Operators of biogas plants receive 8.4–11.5 cents for the electricity they contribute, power-heat cogeneration operators 1.2–5.1, and owners of photovoltaic plants between 32 and 43 cents (in the past as much as just under 60 cents). Although the wind-power and photovoltaic lobbies invariably insist that feed-in remunerations are not subsidies, in real terms this is in fact the case, even though in Germany (unlike the Netherlands and other EU states) they are not paid directly by the government.

From the allocation point of view it makes no difference who puts up the money for these subsidies, or who passes it on to the plant operators. Subsidies are normally criticized by economists because in most cases they lead to distortions. According to EU legislation they are usually not even permissible. However there are external effects involved in energy production, and the agents causing these effects pay nothing (or too little) for them. Accordingly, the question that poses itself is whether in a so called 'second-best world'[23] subsidies for environment-friendly technologies may not be justified after all, if the prices imposed on CO_2 emissions do not reflect the true marginal damage.[24] Indeed, Bläsi and Requate (2009) show that in such a situation subsidies can close the

[23] Economists refer to second-best solutions if the economy's maximum welfare cannot be attained, but certain constraints have to be considered. For example, it may not be feasible to tax CO_2 emissions according to the true marginal cost (see next footnote). In this case one can look for the next best (or second-best) solution to curb CO_2 emissions.

[24] Environmental economists assessing climate damages estimate the global marginal damage of a ton of CO_2 at 30€ to 50€. See Tol 2002a; 2002b; 2005; 2009.

gap between the marginal damage caused by CO_2 and the actual price for emissions. But the conclusion to be drawn from this is that a uniform price should be paid for all electricity feed-ins regardless of the production methods involved. Market forces will then guarantee that only the most efficient renewable-energy technologies will be used. Seen thus, a feed-in remuneration of approx. 6–8 cents per kilowatt hour would be justified, i.e. the present remuneration rate for electricity infeed from wind energy. In reality, however, a great deal more is paid for certain kinds of energy production, notably the photovoltaic variety. If we look at the marginal cost of abating CO_2 by employing photovoltaic technology, the IEA (see IEA 2008) has even calculated a figure of around 1000€ per ton. Moreover, we must proceed on the assumption that in the near (and more remote) future photovoltaic energy will hardly be competitive at feed-in remuneration rates lower than 10 cents. Accordingly, subsidization for this technology is completely nonsensical in economic terms. It is also more than doubtful whether the promotion of offshore wind power would stand up to cost-benefit analysis. The 'dena'-study (see dena 2005) calculates specific marginal abatement costs of 95€ to 168€ per ton for offshore wind-power plants, whereas experts calculate the marginal damage to be 50€ at the most.[25]

Interestingly, formerly communist-governed Poland now also has a system of feed-in remuneration for electricity from renewable resources. The rate here is approx. 8 cents, regardless of the power source and the technology with which it is produced (in Poland most of it comes from biomass combustion). In Poland, the market decides which technologies are used. This policy is a great deal more efficient than the system of differentiated feed-in rates we find in Germany and various other European countries.

After the introduction of emissions trading in Germany in 2005, the then minister of Economic Affairs Wolfgang Clement called for a review of feed-in remunerations for electricity from renewable energies, arguing this being in conflict with emissions trading. Indeed, emissions trading and feed-in remunerations are incompatible with one another. The original purpose in promoting renewable energies was to lower conventionally produced electricity and with it CO_2 emissions. But the introduction of emissions trading imposed a ceiling for the total amount of emissions. If more electricity from renewable energies is fed into the mains, the effect of renewable energy capacity extensions on the CO_2 emissions is almost nil, unless the price for emission certificates has dropped to zero. It is indeed true that the demand for CO_2 emission will initially drop if more electricity from renewable resources arrives on the market. But this also lowers the price for certificates, thus giving the companies forced to participate in emissions trading fewer incentives to abate CO_2 emissions. Emission certificates no longer required by a company are sold to other companies, so the overall emissions stay the same. In other words, the CO_2 emissions reduced in one place (e.g. on the coast) by the use of renewable energies are offset in other places. And this shifting of emissions has no effect whatsoever on the global climate.

The situation would be different if emissions were regulated by an emission tax rather than in terms of the overall amount. Model-theoretic considera-

[25] See last footnote.

tions indicate that in such a case subsidies for renewable energies would indeed lower CO_2 emissions from conventional electricity production (see Bläsi/Requate 2009). To adhere to emissions trading and produce a positive environmental effect at the same time, it would make sense to bolster the price of emission certificates via an open-market policy. This means that the EU would have to buy up certificates from the market to maintain the price for emission certificates. This really would reduce CO_2 emissions.

Despite these problems, defenders of the feed-in-tariff system argue that these kinds of subsidies are necessary to promote CO_2-free technology, and they stress the long term effects of such measures. Wind power and photovoltaic technology would otherwise have no chance to penetrate the market. They also argue that there are strong learning effects in the production of wind turbines and photovoltaic panels, and that these learning effects can only be realized if governments boost the demand for such equipment. Finally Diekmann and Kemfert (2009) argue that promoting renewable energy shifts down the economy's aggregate abatement cost curve, and as a consequence less permits need to be issued in future permit trading phases, in particular in the years after 2012. These arguments are not quite sound. First of all, in contrast to wind power, which certainly has a good chance to be become a major source of energy production in the future even at market prices, this is much different for technologies such as photovoltaic energy. Due to increasing scarcity and therefore increasing world market prices of silicon, a major compound for producing such panels, a sharp decrease of production cost is unlikely. My forecast is that photovoltaic energy will never become competitive due to its low energy production efficiency. It will rather be leap-frogged in other countries and substituted by much different and more efficient technologies such as parabol solar power plants. Put differently in economic terms, subsidizing technologies such as photovoltaic energy today ignores the option value to wait for better, more efficient technology coming up in the future. One euro invested in photovoltaic energy today cannot be invested in better technology in the future, and so cannot be used for research and development of better technology.

Secondly, the learning effect argument is weak too. Learning effects are present everywhere. Unless there are strong learning spill-overs, learning effects are fully internalized by the firms. Firms know they learn by increasing production and are ready to accept prices below average cost in the early phase of production and marketing, but will make profits in the future and thus cover those early losses.[26]

Finally the dynamic policy argument put forward by Diekmann and Kemfert (2009) is also questionable. Subsidizing renewable energy is an expensive measure to shift down the (marginal) abatement costs, and thus demand for emission permits. It also turns the idea of emissions trading upside down. For the idea of emissions trading was to take advantage of the cheapest abatement opportunities. By subsidizing particular forms of renewable energy we exploit the most

[26] In a seminal paper Petrakis et al. (1997) show that learning-by-doing does not cause market failure if there are no learning spill-overs.

expensive forms of saving CO_2 emissions. Moreover, other countries that do not pay these high feed-in tariffs will free ride on Germany' high subsidies.

7. The Latest EU Resolution

Under the German Council presidency in 2007 and motivated by the fourth IPCC Report (see Parry et al. 2007) and the Stern Review, the European heads of state and government have committed themselves to further measures summarized by the slogan '3 times 20'. First of all, emissions from the EU states are to be reduced by 20% by the year 2020. Secondly, energy efficiency is to be improved by 20%. Thirdly, the share of renewable energies in overall energy production is to be increased to 20%.

The question is whether this plan is rational and can be realized at an acceptable cost. The first goal (20% emission reduction) should be achievable at a cost of less than 1% of GDP, provided emission allocation and emission reductions are efficiently distributed, i.e. the marginal abatement costs for all emission sources are more or less equal. But there are grounds to doubt whether the EU will indeed be employing the instruments that would lead to efficient allocation. Whether these efforts are rational, given massive emission increases in China and other emerging countries, is an entirely different matter. Game theoretic models predict that the response to unilateral emission reductions by one party will be emission increases by other parties.[27] In addition, while CO_2-reducing measures in Europe will indeed initially lower the demand for fossil fuels, they will also lower prices for them. This will increase the demand for fossil fuels in other parts of the world and increase CO_2 emissions there. This is also known as a leakage effect. By assuming that world energy supply is totally inelastic, Sinn (2008a; 2008b; 2008c) even goes so far as to claim that the effect would be 100%. This would mean that every ton of CO_2 reduction in Europe would be 100% offset by higher emissions in other parts of the world, though there is disagreement about the actual extent of the leakage effect. On the other hand, a pioneering initiative by Europe might also trigger a technological development that would be taken up by emerging states and developing countries. It is difficult to forecast which of these factors is likely to prevail.

But what of the two other goals, 20% energy efficiency enhancement and a 20% share of renewable energies? Basically, these targets are derivative goals, i.e. potential interim stages in the attempt to achieve overall emission reduction. Here the first question is what instruments are to be used to achieve an increase in energy production efficiency. So far, the EU has failed to come up with any proposals. Secondly, it is questionable whether the derivative targets will in fact encourage higher overall efficiency. If the EU-commission included all CO_2-intensive sectors in emissions trading and at the same time reduced the upper emission limit by 20%, this would automatically provide incentives to achieve CO_2 emission reductions, not least via efficiency enhancement. Much the same is true in connection with the goal of increasing the share of renewable energies

[27] See for example Hoel 1992; Barrett 2004 and more recently Sinn 2008a;b.

to 20%. The use of renewable energies is indeed a potential way of reducing emissions. But it is doubtful whether an exact share of 20% would be cost-efficient. In an economic recession, emission reductions can be achieved with a lower share of renewable energy sources. In a boom, on the other hand, a higher percentage of renewable energies would be required to achieve the same emission goal. In fact, the aim of a 20% share for renewable energies looks very much like a relative standard defining emissions per unit of output. And one thing we know about relative standards is that they are rarely efficient.[28]

In short, the '3 times 20' program appears to be largely symbolic. Both a 20% increase in energy efficiency and the increase of the share of renewable energies to 20% could turn out to be an expensive way of achieving a 20% reduction of CO_2 emissions. It would be much better to leave it to the market to determine how the economy can achieve a 20% reduction of emissions in an efficient manner.

8. The German Environment Minister's Measures for 40% Emission Reduction

After the EU summit 2008, the German environment minister quickly presented a large-scale program for no less than a 40% reduction of Germany's emissions by 2040. But most of these goals are not to be achieved via market-economic instruments but by statutory standards, such as heat insulation standards for buildings, fuel-consumption standards for vehicles, a ban on conventional light bulbs, and regulations for efficiency standards in power parks. Though no precise information is given on how the individual reductions are to come about, the assumption appears to be that emission coefficients (e.g. in power stations and cars) will improve, while the behavior of economic agents will stay the same until the standards have been achieved. But it is safe to predict some very considerable changes in behavior. For example, if the energy consumption of a light bulb is reduced to a quarter of what it was before, it is entirely rational for the consumer to leave the lights on longer because it has become a great deal cheaper to do so. Changes of behavior like this are also referred to as a 'rebound effects'. This effect expresses the percentage to which energy saving through improved technology is offset by increased consumption of the relevant service due to a reduction in variable costs. Wirl (1997) has shown that in theory this rebound effect may in fact be higher than 100%, i.e. the use of improved technology can actually lead to an increase in energy consumption and CO_2 emission. In an empirical investigation, Frondel et al. (2007) estimate the rebound effect in the transport sector to be as high as 60%. In other words, a large proportion of efficiency increases goes for nothing as long as the prices for energy or CO_2 do not rise. A similar rebound effect may also occur in the use of heating, etc.[29]

Another shortcoming of the Federal government's program for reducing CO_2 is that it seriously violates the principle of equal marginal abatement costs. In

[28] On this point see Ebert 1998. The reason is that in general relative standards are not an incentive to economize on energy and hence lead to excessive energy consumption.

[29] For an overview of rebound effects see Greening et al. 2000.

addition, some of the goals, like increasing the share of renewable energies in electricity production, are again only derivative goals on the way to reducing CO_2 emissions. As with the derivative goals of the EU, it is doubtful whether the environment minister's program is the most efficient way of achieving the real goal, emission reduction. Further efficiency enhancement of electricity production in power stations may be less costly than the massive promotion of renewable technologies. Accordingly, it would be better merely to set the emission goal in the form of an overall emissions limit, issue the corresponding number of emission certificates, and induce efficient allocation via market trading.

9. Summary and Conclusions

The purpose of this article was to examine the efficiency of European and German environment and climate policy. The EU climate goals are very ambitious. This makes efficient allocation of the reduction measures doubly important, as European companies have to compete with companies from East Asia, an area where governments have not entered into any commitments in connection with CO_2 reduction. On the contrary: every year, China installs a power-station capacity equivalent to the entire annual power consumption in the United Kingdom. The main obstacle on the route to efficient CO_2 reduction at the European level is the discrepancy in marginal abatement costs between sectors forced to participate in emissions trading and those not obliged to do so because they are subject to other measures. Marginal abatement costs outside the trading sector can be around 10 times higher than in the trading sector. Another error committed at the European level is the decision in favor of free certificate allocation as opposed to auctioning. This has given the member states too much freedom in devising the allocation rules, partly resulting in a high degree of inefficiency. It is fair to say, however, that starting in 2013 emission permits will be auctioned off in the entire EU.

This article has also leveled criticism at the German policy for promoting renewable energies. First of all, subsidizing electricity feed-ins from these quarters is incompatible with emissions trading, as electricity from renewable energy sources cannot lower CO_2 without a simultaneous reduction of available certificates. Also, differentiation of feed-in tariffs according to the way electricity is produced will not divert the scarce resources to those areas where power from renewable sources is produced most efficiently. Finally, we have made a critical assessment of the latest measures by the EU and the German government to cut down on CO_2. In view of the rapid increase in emissions in south and east Asia, the imposition of numerous individual measures is likely to be unnecessarily expensive for the German economy while at the same time achieving little benefit for the global climate.

Bibliography

Barrett, S. (1994), Self-enforcing International Environmental Agreements, in: *Oxford Economic Papers* 46, 874–894

Bläsi, A./T. Requate (2010), Feed-in-Tariffs for Electricity from Renewable Resources, in: *Public Finance and the Environment*, fortcoming

BMU (2007), *Erneuerbare Energien*, URL: www.bmu.erneuerbare-energien.de/inhalt/5982/2676/

Dena (2005), *Energiewirtschaftliche Planung für die Netzintegration von Windenergie in Deutschland an Land und Offshore bis zum Jahr 2020*, Studie im Auftrag der Deutschen Energie-Agentur GmbH (dena), Endbericht

Diekmann, J./C. Kemfert (2009), *Förderung erneuerbarer Energien und Emissionshandel: wir brauchen beides*, Wochenbericht des DIW Berlin 11/2009, 169–174

Ebert, U. (1998), Relative Standards: A Positive and Normative Analysis, in: *Journal of Economics* 67, 17–38

Europäische Gemeinschaft (2000), *EU Richtlinie 2000/60/EG des europäischen Parlamentes und des Rates, vom 23. Oktober 2000 zur Schaffung eines Ordnungsrahmens für Maßnahmen der Gemeinschaft im Bereich der Wasserpolitik*, Amtsblatt der Europäischen Union

— (2003), *Richtlinie 2003/87/EC des Europäischen Parlaments und des Rates über ein System für den Handel mit Treibhausgasemissionszertifikaten in der Gemeinschaft*, Amtsblatt der Europäischen Union

European Environment Agency (2008), *Greenhouse Gas Emission Trends and Projections in Europe 2008—Tracking Progress towards Kyoto Targets*, EEA Report No. 5/2008, Copenhagen

Frondel, M./J. Peters/C. Vance (2007), *Identifying the Rebound: Theoretical Issues and Empirical Evidence from a German Household Panel*, RWI-Discussion Paper

Greening, L. A./D. L. Greene/C. Difiglio (2000), Energy Efficiency and Consumption —The Rebound Effect—A Survey, in: *Energy Policy* 28(6–7), 389–401

Hoel, M. (1992), International Environmental Conventions: The Case of Unilateral Reductions of Emissions, in: *Environmental and Resource Economics* 2, 141–159

IEA (2008), *World Energy Outlook*, Paris, IEA/OECD

Kempfert, C./T. Traber/T. Truong (2007), *Comprehensive Package of Climate Measure Could Substantially Decrease Cost of Emission Reductions in Germany*, German Institute for Economic Research (DIW Berlin), Weekly report No. 3/2007, 15–20

Klepper, G./S. Peterson (2006), Emissions Trading, CDM, JI, and More—The Climate Strategy of the EU, in: *The Energy Journal* 27(2), 1–26

Parry, M. L./O. F. Canziani/J. P. Palutikov/P. J. van der Linden/C. E. Hansen (2007) (eds.), *Climate Change 2007: Mitigation of Climate Change: Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel of Climate Change*, Cambridge

Petrakis, E./E. Rasmusen/S. Roy (1997), The Learning Curve in a Competitive Industry, in: *RAND Journal of Economics* 28, 248–268

Requate, T./W. Unold (2003), Environmental Policy Incentives to Adopt Advanced Abatement Technology—Will the True Ranking Please Stand up?, in: *European Economic Review* 47, 125–146

— / — (2001), Pollution Control by Options Trading, in: *Economics Letters* 73, 353–358

Sinn, H. W. (2008a), *Das grüne Paradox, Plädoyer für eine illusionsfreie Klimapolitik*, München

— (2008b), Das grüne Paradoxon: Warum man das Angebot bei der Klimapolitik nicht vergessen darf, in: *Perspektiven der Wirtschaftspolitik* 9, 109–142

— (2008c), Public Policies against Global Warming, in: *International Tax and Public Finance* 15, 360–394

Stern, N. (2006), *STERN REVIEW—The Economics of Climate Change*, Cambridge

Tol, R. S. J. (2002a), New Estimates of the Damage Costs on Climate Change, Part I: Benchmark Estimates, in: *Environmental and Resource Economics* 21(1), 47–73

— (2002b), New Estimates of the Damage Costs on Climate Change, Part II: Dynamic Estimates, in: *Environmental and Resource Economics* 21(2), 135–160

— (2005), The Marginal Damage Cost of Carbon Dioxide Emissions: An Assessment of the Uncertainties, in: *Energy Policy* 33(19), 2064–2074

— (2009), The Economic Effects of Climate Change, in: *Journal of Economic Perspectives* 23, 29–51

Weitzman, M. (1974), Prices vs. Quantities, in: *Review of Economic Studies* 41, 477–491

Wirl, F. (1997), *The Economics of Conservation Program*, London