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SOLVING THE KYOTO-PARADOX

AN EVALUATION OF KYOTO MEASURES WITH RESPECT TO NATIONAL CO-EFFECTS

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Abstract:

As signatory to the Kyoto Protocol several nations have agreed to reduce its greenhouse gas emissions as a global objective against climate change. Using public funds to reach this international aim is sometimes seen in concurrence to the promotion of national objectives such as reducing unemployment or increasing the competitiveness of the national economy.

It is therefore often argued that the cheapest way of meeting the Kyoto target should be employed, in many cases this will be the buying of certificates from CDM projects internationally. However, if we consider also, that domestic greenhouse gas mitigation projects have positive effects on the aforementioned other policy goals such as unemployment reduction or innovation policy, guying cheap certificates could well turn out as "expensive" in terms of overall goal achievement. In other words: Implementing national policies jointly with the international obligation to meet the Kyoto target could well free additional resources for climate policy, and thus, putting some weight on national interests besides the international Kyoto obligation may well turn out to be in the interest of climate policy. We would like to call this the "Kyoto paradox".

In an attempt to solving this paradox, we suggest a method of linking the intended benefits of specific greenhouse gas reduction policies with their respective (intended or unintended), but largely implicit, national co-effects. The method can be extended to cover any number of climate mitigation measures or pollutants. This thus provides decision makers a good argumentation base for promoting greenhouse gas mitigation measures with public funds through assessing and ranking a large number of these measures in terms of their national co-effects.

Keywords: Climate change mitigation, co-effects

JEL Classification: C65, H23, Q28, Q48, Q51

1 Problem Definition

Several nations have committed themselves to reducing greenhouse gas emissions under the framework of the Kyoto protocol. To reach this international objective national governments employ national funds – that in general could also be used for other policy goals of national interest such as unemployment reduction or innovation policy in order to increase the competitiveness of the domestic economy. It therefore is often argued, that the cheapest way of meeting the Kyoto target should be employed, in many cases this will be the buying of certificates from CDM projects internationally. However, if we consider also that domestic greenhouse gas mitigation projects have positive effects on the aforementioned other policy goals such as unemployment reduction or innovation policy, guying cheap certificates could well turn out as "expensive" in terms of overall goal achievement. In other words: Implementing national policies jointly with the international obligation to meet the Kyoto target could well free additional resources for climate policy, and thus, putting some weight on national interests besides the international Kyoto obligation may well turn out to be in the interest of climate policy. We would like to call this the "Kyoto paradox".

This "Kyoto paradox" results for policy makers often in a conflict of objectives, which often leads to decisions towards national aims and against superficial non-national aims in many cases.

Clearly, one argument in favour of domestic greenhouse gas mitigation concerns greater consideration of the so-called co-effects of emission stabilization measures. Co-effects are the ancillary effects of climate protection policies, and although they get relatively little consideration (if at all) in policy assessment, they can be of considerable benefit, e.g. the creation of additional domestic employment. The various manifestations of such co-effects have already been thoroughly described in the existing literature, and quantification of relevant costs has also been attempted. We give a systematic overview on this in chapter 2

However, the comparison of estimated avoidable costs for various policies is extremely difficult, e.g. comparing the cost of avoiding damage caused by non-climate pollutants with that of various macroeconomic effects. Although quantitative analyses of co-effects exist, still relatively little is known about their relevance in terms of selecting or prioritizing climate measures. Such information would obviously be of benefit to decision makers and this why we propose a method to weigh these benefits against each other in chapter 3 while giving some exemplary results in chapter 4.

2 Ancillary Effects (Co-Effects) of Climate Measures

The high uncertainty associated with the potential future impact of greenhouse gases on human and animal life makes it extremely difficult to forecast expected levels of damage. Not only the problem of correctly discounting potential damage, but also the fact that some climate gases have no harmful effects on human populations, make quantifying the costs arising from climate gas externalities a highly complex affair.

In general, greenhouse gas mitigation measures also lead to a reduction in non-climate related pollutants. The damage caused by such pollutants is often quite clear, and their related costs can often be determined even when the polluter does not face market prices for the costs concerned.

In addition to paying relatively little attention to the impact of present and future negative externalities arising from climate mitigation measures, there is also a tendency to neglect the macroeconomic costs associated with an increase in the use of fossil fuels. These are often simply ignored in the design of climate strategies even though the related potential benefits might be considerable. “Recent studies suggest that under some scenarios where baseline conditions include relatively high levels of pollution and inefficient abatement technologies, ancillary benefits of greenhouse gas mitigation policies can be of the same magnitude as the costs of proposed mitigation policies.”(Davis/Krupnick/McGlynn, 2000, 9) One example of such costs might be a worsening of the trade balance as a result of increased use of imported fossil fuels, compared to a position involving greater use of domestic fuel sources.

In the text below we briefly discuss the costs of greenhouse gases, how they might be reduced as a result of climate mitigation policies, and the additional benefits that might be derived from decreased use of fossil fuels. We distinguish between three types of co-effect, i.e. the negative externalities associated with climate mitigation measures, macroeconomic impacts, and those effects which can be linked to energy supply risk.

The first type of co-effect covers the impact of environmental pollution on individuals, who are forced to incur costs without receiving compensation, and for whom such costs can be reduced through appropriate climate mitigation policies. The second type of co-effect largely concerns itself with the impact of greenhouse gas stabilization measures, as reflected in the relevant markets. The third type of co-effect deals with factors that have received relatively little attention in the discussion of climate strategy, namely, the social and economic risks associated with the provision of an adequate energy supply. In times of rising oil prices and political instability in the Near East, it is no surprise that such risks are receiving ever more public attention. Even here, a careful choice of climate strategy may be of great service in that it helps reduce supply risk.

2.1 THE EXTERNALITIES OF CLIMATE MITIGATION MEASURES

We are concerned here with those externalities resulting from the use of fossil fuels which might be partly or completely avoided upon implementation of climate mitigation policies.

The effects dealt with here relate solely to so-called technological externalities. These are taken as given, and arise when the actions of one group of individuals have a direct impact on the welfare or production functions of others, even where these effects are not explicitly intended (Hussen, 2000, 98).

It should be noted that the following observations only cover those forms of pollution which arise from the combustion of fossil fuels. Although it appears likely that climate change will have a negative impact on human and ecological systems, too much uncertainty concerning actual impact in various fields remains, and thus no comment on the general impact of greenhouse gases is made here.

2.1.1 Health Effects

Several studies have dealt with the possible decline in deaths (with respect to a baseline scenario where no action is taken to limit greenhouse gases), that could be achieved should climate mitigation policies be adopted, e.g. fewer deaths from bronchitis, asthma, heart disease etc. According to Auman et al, 2000, health effects make up 70-90% of all co-effects. However, it also needs to be noted that the nature of health effects depends closely on the policies actually chosen. For example, the substitution of biomass for natural gas in a heating system, may result in a higher health risk due to a greater amount of particulate matter being released into the atmosphere.

2.1.2 Ecological Effects

At present, the ecological impact of fossil fuel use is mostly evidenced in the form of acid rain, low-level ozone, and eutrophication. The impact on ecosystems can be seen in the form of crop damage and forest die-back. The reduction in the number of CO2 sinks as a result of deforestation leads to a worsening of soil quality and often causes irreparable damage. “Soil erosion in agricultural areas leads to loss of production and weakens the buffer effect with respect to pollutants” (Kilk, 2001, 39).

2.1.3 Damage to Buildings

In this area, climate mitigation policies may help reduce costs associated with maintenance and replacement, e.g. replacement of protective layers after erosion, or additional cleaning or painting of facades made necessary as a result of discoloration. Quantification of building damage is a highly complex and challenging process. “The role of atmospheric NO2 has not been clarified. Although a strong synergistic effekt with SO2 has been observed in laboratory studies, this has not yet been observed in the field.” (European Commission, 1999, 387)

2.2 MACROECONOMIC IMPACT OF CLIMATE MEASURES

In contrast to the externalities associated with greenhouse gas mitigation discussed above, the impacts of relevant macroeconomic externalities are revealed through markets, thus making their quantification considerably less challenging. The effects discussed here relate to those economic and social factors that are linked to fossil fuel reduction, and they are often at the centre of public attention.

One critical observation needs to be made at this point. Large variation in the results of various studies often serves to strengthen the political acceptability of policy measures for this or that group. This is reflected in the fact that different study groups choose widely different initial assumptions and time horizons as a basis for their research.

2.2.1 Impact on GDP

There is widespread agreement that climate mitigation measures can exert a positive impact on GDP. For example, according to Kletzan et al (2005), in one scenario, if no climate related investments had been undertaken as part of the domestic environmental support programme, and the funds had been shared out proportionally among domestic sectors to stimulate additional demand, the Austrian GDP in 2004 would have been (at most) € 160m lower than was in fact the case for the same year, where support funds to the value of € 51m and an investment volume of € 232m were actually employed.

2.2.2 Impact on Employment

Increasing reductions in the use of fossil fuels calls for greater domestic energy production. It is generally agreed, that the additional employment arising as a result of substituting biomass for fossil fuel sources will be more than sufficient to compensate for the reduction in employment in the oil processing industries. Improvements in building insulation is another area where climate mitigation policies will have a positive impact on employment levels.

Kletzan et al (2005) calculated that the domestic environmental support programme mentioned above, which serves largely to promote climate-related investment projects, was responsible for the creation of an additional 3,000 (net) jobs in the period under observation (Kletzan et al, 2005, 3).

2.2.3 Impact on Regional Income Distribution

Reductions in the import of fossil fuels, whether as a result of substitution or of increased efficiency, aids retention of purchasing power among the domestic population. This is especially true for low income, agricultural regions. Increased use of biomass in such regions is proving a particular blessing. The improvement in purchasing power leads to less migration away from the region, and thus to a reduction in purchasing power outflow.

According to the European Commission, greater exploitation of biomass in the energy sector, could, by the year 2010, and for the whole EU area, lead to the creation of an additional 250,000 to 300,000 jobs in rural areas, and to reductions in C02 of 200m tonnes per year (http://www.lebensministerium.at/article/articleview/42187; 21.08.2006).

2.2.4 Impact on the Balance of Trade

Substituting domestic fuel sources for imported fossil fuels is not the only means available for reducing the burden on the balance of trade. Improvements in energy technology and the development of more energy efficient products also offer substantial competitive advantage in the export sector (first mover advantages). “Austria has not only plenty of biomass that could be used sustainably but has also the prototypes of advanced biomass technology that could prove very competitive and profitable on international markets.” (Kratena/Schleicher, 1999, 15)

2.2.5 Impact on Public Finance

Climate policies can both reduce the burden on the public budget as well as raise it. For example, where they result in higher employment, there will be a corresponding increase in income tax revenues and a reduction in funds needed for unemployment benefits. On the other hand, any increase in support payments for climate projects represents an additional burden on public funding systems. In a similar manner, if only more indirect, we can also speak of a reduction in the burden on public budgets which may arise from a reduced necessity to provide back up systems to counteract potential bottlenecks or failures in energy supply based on fossil fuels (see also section 2.3). A further reference to the study by Kletzan et al (2005) should aid clarity here. They establish that a public funding increase of (maximum) € 89m was achievable in 2004 by using funds for climate projects, compared to their use in the alternative described in section 2.2.1 above.

2.2.6 Induced Technological Change

According to Bauman (2004), environmental pollution is a form of waste. "Efforts to reduce pollution and efforts to maximize profits share the same basic principles, including the efficient use of inputs, substitution of less expensive materials and the minimization of unneeded activities." (Bauman, 2002, 2) The trend towards ever greater technological efficiency is likely to be reflected in rising economic output and higher affluence: "… a well designed emission reduction policy will not only achieve even ambitious reduction targets but also stimulate economic activity and yield net benefits." (Kratena/Schleicher, 1999, Abstract)

2.3 IMPACT OF CLIMATE POLICIES ON ENERGY SUPPLY RISK

In matters concerning energy policy, dependencies represent a form of risk which is highly complex and thus difficult to calculate. Owing to the relatively limited supply of crude oil and natural gas within the EU's borders, and also to the EU's lack of competitiveness with respect to coal production, there is clear potential for energy uncertainty. Such uncertainty may arise as a result of instabilities in the global market, political or social tensions in transit or supplier countries of fossil fuels, or through deliberate manipulation of supply quantities. The risks of cartel formation, or war, may also be included here.

The European Commission defines energy security as a state in which consumers and governments may assume that sufficient reserves and production and distribution facilities are available, such that they will be in a position to satisfy their needs in the foreseeable future at competitive market prices, either from domestic or foreign sources. Thus, the term energy insecurity implies a situation in which insufficient quantities of fossil fuels are available, or in which there are sudden or sharp changes in fuel prices (Markandya/Hunt, 2004,1).

In the following text, we now discuss those costs which may arise as a result of dependencies on fossil fuels, and how they could be reduced by implementing climate policies designed to lower the demand for fossil energy sources. It is important to note, however, that the costs of energy insecurity have already been partly internalised. For reasons of methodology, these will not be dealt with in any further detail, and by way of illustration one example will have to suffice, i.e. the costs of maintaining the strategic oil reserves of the OMV are already reflected in the company's petrol prices.

2.3.1 Costs of Preventive Measures

Nations are prepared to pay for the possibility of avoiding bottlenecks or breakdowns in energy supply. Such costs can be reduced where greenhouse gas stabilisation policies lead to lower consumption of fossil fuels.

One approach to determining such costs involves the assumption that countries are willing to employ certain measures in order to reduce the probability of such economic risk. The Nabucco Pipeline Project, (http://www.de-world.de/dw/article/0,2144,1849073,00.html; 23.08.2006), in which the Austrian company, OMV, plays a leading role, aims to reduce dependency on supplies of natural gas from Russia, and can be seen as an attempt to raise diversification with respect to exporters of fossil fuels.

2.3.2 Costs of Stochastic Bottlenecks of Breakdowns in Fossil Energy Supply

Although in 2002, 61% of Austrian electricity was derived from hydropower, calorific power stations still accounted for 37%. (http://www.umweltbundesamt/umweltschutz/energie/energie_austria/; 23.08.2006)

This is still a significant quantity and thus involves certain risks should fossil energy supply breakdown and lead to increased costs in electricity supply. This could be for example, costs arising due to increased employment of police, emergency services or military personnel, or due to delays incurred in public transport, e.g. in tram and train services (Markandya/Hunt, 2004, 21). It need also be noted that disruptions (physical or financial) to electricity supply cause damage to domestic production . In addition to the long term barriers to new investment faced by energy intensive plants, such disruptions are a further point of criticism. As stated in an article published by the Institute for Industrial Science (the original text was called, “Die volkswirtschaftliche Bedeutung einer gesicherten Stromversorgung”), breakdowns in electricity supply cost on average € 8.09 /kWh. (http://www.iv-mitgliederservice.at/iv-all/dokumente/doc_2125.pdf; 23.08.2006)

3 Using National Non-Climate Criteria in the Selection of Climate Policies – A New Method

Taking these co-effects of climate change mitigation measures into consideration, decision makers can solve the Kyoto-paradox by finding an increased popularity for its actions to reach the international aim climate protection. However, to obtain enough support for climate change mitigation measures, domestic decision makers have to provide their citizens examples of domestic benefits from domestically paid international activities. Furthermore, an efficient use of public funds is essential for the acceptance of climate actions by the citizens.

Decisions related to general questions of climate, or to specific climate policies should in principle, always be based on a thorough and comprehensive cost-benefit analysis for the economy as a whole. In designing and implementing climate policies, the related policy costs play a crucial role. There are those who argue that the full costs of climate measures need not be taken into account when as a result of adopting such measures costs in other areas might be reduced, e.g. a fall in the costs associated with particulate reduction. When, however, a calculation method is chosen whereby climate measures are to reflect their full costs, then it is only appropriate that the value of the full benefits arising from their implementation also be used as an offsetting measure, e.g. the value of benefits arising due to the avoidance of negative externalities, or the additional benefits of increased employment. The realities of political and economic policy making indicate, however, that such comprehensive cost-benefit calculations are regarded as excessive and thus are hardly ever carried out.

Such a context facilitates the search for alternative policy tools, i.e. tools that might aid decision making when it comes to improving selection of greenhouse gas (GHG) mitigation measures. JOANNEUM RESEARCH has developed a policy tool that allows GHG mitigation measures to be ranked in order to ensure an efficient use of public funds, and thus promises to simplify the selection process. The new approach is based on distributing the costs of specific climate policies with respect to their associated co-effects. It thus invites us to systematically include the impacts (at least those presently known) of co-effects in the design of climate policy. The method allows one to set priorities with respect to environmental or macroeconomic variables, and also allows one to consider questions of energy security by incorporating the latter as a qualitative variable (for example in the form of a policy floor with respect to climate quality).

The purpose of the new policy tool is to establish which of the numerous climate measures available, in terms of implementation costs (support programmes, subsidies of national public funds etc.), leads to the greatest reduction in pollutants and greenhouse gases, while simultaneously taking into consideration any respective benefits for the domestic economy (as indicated by impact on domestic output). Here, the best measure is shown to be that which produces the smallest ratio between implementation costs on the one hand, and a reduction in pollutants and greenhouse gases and an increase in domestic value added on the other hand.

Assuming there to be a fixed budget available for climate policies, we arrive at the following formula:

$$\frac{I_m}{\left[1+\sum_{i=j}^{k}\left(\alpha_i * R_{im}\right)\right] * \beta + \Delta V_m} \Rightarrow \min.$$

Where:

I_m *Implementation cost of climate policy m per tonne CO₂ saved,* $0 \leq I_m < \infty$

α_i *Weighting factor for the local pollutant i,* $(i \in j,...,k)$, $0 \leq \alpha < \infty$

R_{im} *ratio of reduction in local pollutant i to a one unit reduction in* CO_2 *for policy measure m,* $0 \leq R_{im} < \infty$

β *amount of domestic value added which society is willing to sacrifice in order to save one unit of* CO_2, $0 \leq \beta < \infty$

ΔV_m *additional value added created by policy measure m per tonne* CO_2 *saved,* $0 \leq V_m < \infty$

Variable I_m (*Implementation cost of climate policy m per tonne* CO_2 *saved*), refers here to the amount of subsidies and support funds per tonne CO_2 saved, for the greenhouse gas mitigation policy m, and is measured in terms of the technical life of the policy. In order to answer the question which policy should best be supported by the limited public funds available, the policy tool has to focus on necessary funding quantities and not on the investment costs that such policies incur. This evaluation method can be extended to cover any number of possible policy measures.

The denominator measures the quantity of CO_2 saved, other relevant pollutants in terms of their respective weights, and the effect of policy *m* on the domestic economy.

The component $\left[1+\sum_{i=j}^{k}(\alpha_i * R_{im})\right]$ in the denominator measures environmental impact. R_{im} indicates the amount of pollutant *i* saved with respect to policy *m* for every tonne of CO_2 saved as a result of the same policy *m.* This variable can thus be used to indicate the relationship between increased pollutant avoidance and CO_2 reduction for the technology at hand. This is complemented by the variable α_i, which measures the value of the damage resulting from pollutant *i* compared to the climate gas CO_2. This 'damage conversion factor' is necessarily a subjective measure and will vary from country to country according to the given preferences of the population or the preferences of the local administration.

The term $\sum_{i=j}^{k}(\alpha_i * R_{im})$ in the environmental component, is thus the sum of all pollutant reduction for the pollutants *j,...,k,* $(i \in j,...,k)$, expressed in units of 'CO_2 equivalent '. Thus, the whole environmental component in the formula indicates both the amount of CO_2 and the amount of local pollution expressed as CO_2 equivalent, that can be avoided for a climate policy entailing support cost I_m.

Economic impact is expressed in the policy tool formula by the variable ΔV_m. This expresses, in monetary terms, the additional value added through investment in policy measure *m* per tonne of CO_2 saved. It represents the difference between the value added through using this money for climate change mitigation measures and the value added through applying the same amount of money to the existing domestic budget without these measures.

In order to find a suitable means of comparing the environmental and economic components, we need to introduce a further weighting factor, β. To determine the value of such a factor we have to ask how much more value added is equal to one tonne of CO_2 saved? One possible answer might be found by collecting data on the subjective value a society places on climate policy compared with an increase in the value of GDP. This is by no means an easy task. However, as a starting point for estimating the social value of CO_2 reduction, one might begin by drawing on the amount that a country is willing or obliged to pay for climate policy, for example as expressed in the purchase of JI/CDM credits (these do not raise domestic value added). It may be expected that when deciding on how to save one tonne of CO_2, countries will be indifferent towards policies offering a choice between spending a given sum on JI/CDM credits or using the same sum for domestic projects with the same impact. By investing in domestic measures a government is able to 'purchase' a certain amount of domestic value added, which is worth, let's say, *x* euros. Thus, when a country, either voluntarily or involuntarily, purchases emission credits from other countries, the quantity *x* represents the value of the additional output expressed in euros which the society is prepared to sacrifice for one tonne of CO_2 saved. The value of *x* can thus be taken as a legitimate estimate of the general value β, this latter then being used to assess the relative value of all possible climate mitigation policies. In other words β represents the opportunity costs of purchasing JI/CDM credits abroad, expressed in terms of euro domestic value added.

Any argument along the lines that Austria can or should meet its Kyoto commitments by purchasing JI/CDM emission credits from other countries is thus also an implicit statement concerning the respective value of climate mitigation compared with an increase in GDP (either for society as a whole or for the specific group in question). The explanation above shows that for a given emission certificate price, a corresponding β value would have to be calculated for every single measure.

Irrespective of the method used to determine β, the policy formula can be applied to any desirable climate policy in such a way that for a given β value, a ranking of all possible policy measures becomes possible. The formula also allows for more precise specification of social or group values with respect to climate mitigation, environmental concerns in general, and the respective trade offs in terms of economic well-being.

Taking an extreme case where there is a strong social preference for climate or environmental protection, the environmental component dominates the economic component in the formula, and we find $\beta \to \infty$. The economic component is thus automatically marginalized. In the opposite case where society places a much greater value on economic well-being compared to climate or environment, we find in contrast to the above that $\beta \to 0$

In the case where there is a strong preference for environmental protection in general (i.e. there is a strong aversion to non-climate pollutants), the economic component again loses force, but in contrast to the first extreme case above, this is given by $\alpha \to \infty$ (subject to the constraint that $\beta > 0$). Where the question of general environmental protection is excluded from the climate ranking procedure ($\alpha \to 0$), there is a slight reduction in the significance of climate mitigation compared with economic well-being.

This short description of extreme parameter values serves to illustrate the general applicability of the method devised. In reality, such extreme social values are unlikely to occur and some form of balance will be observed (which will vary from country to country). Whatever the balance observed, it will certainly provide for greater transparency in the decision making process.

4 Exemplary Results

By way of illustration, the policy tool described here was applied to five different climate mitigation measures. These comprised: improved building insulation; greater use of biomass in heat and power production, greater use of wind power; two uses of flexible mechanisms whereby a distinction was made between 1) JI/CDM with technology transfer, and 2) JI/CDM without technology transfer. The example used for technology transfer was the JI project *Vacha Cascade*, and that for no technology transfer was the Austrian CDM project*, Procurement and CER Sale Facility.*

A spreadsheet, which was linked to a corresponding diagram, was developed for ranking the different measures. The diagram presents the results gained from the policy formula in the form of straight lines of varying gradient. This simplifies interpretation of the policy rankings. The policy exhibiting the lowest gradient, i.e. that policy measure for which the formula explained above generates the lowest quotient, achieves a higher ranking compared to the other measures under investigation, and this process is continued until all measures have been ranked.

The diagram was used to illustrate how changes in the preferences described above impact on policy measure rankings. The preference settings investigated included a strong preference for climate mitigation (and/or a preference for general environmental protection, subject to the constraint that $\beta > 0$), with $\beta \to \infty$, and a setting with a strong preference for maximizing value added, with $\beta \to 0$. In addition, policy rankings were also analysed for settings in which there was no strong preferences for either environmental or economic factors. In order to illustrate the sensitivity of results to the value of β chosen, the simulation was carried out using two different values for this parameter. These reflect changes in implicit social preferences as a result of changes in observation period. Starting from an initial value for Certified Emission Reductions (CERs) of € 5.35 per tonne CO_2 different β values can be devised depending on the period in which the investment multiplier is allowed to work. The average value for this factor of 2.5 (this is based on data from Kletzan et al, 2005, and Hantsch et al, 2003) relates to a very short multiplier period for all investments (one year), and it is also assumed that part of the initial investment flows abroad without any impact on the domestic economy (as is only to be expected for a relatively small economy). A β value of 8 on the other hand, indicates a longer period of impact for the investment multiplier (Marterbauer, 2003).

While neither of the above two cases is likely to occur in reality, this cannot be said for the following. Here different β values are used to examine cases where either climate mitigation and maximization of economic value (column THG+V), or climate mitigation, economic maximization and pollutant minimization (i.e. general environmental protection) (column THG+V+pollutants) are considered. It is noticeable that a change in the value of β, i.e. a change in preferences, leads to different ranking priorities, particularly with respect to the most favoured policy measures.

Table 1: Climate Policy Rankings of different Scenarios

					β = 2.5		β = 8	
Measure	I_m (per tonne CO_2 saved)	V_{im} (per tonne CO_2 saved)	**THG**	**V**	**THG+V**	**THG+V+ pollutants**	**THG+V**	**THG+V+ pollutants**
Building insulation	€ 25	€ 87	5	3	4	4	4	4
Biomass	€ 3	€ 15	2	2	1	1	2	2
Wind power	€ 1	€ 1.70	1	4	3	3	1	1
JI/CDM with tech. transfer	€ 5.80	€ 30	4	1	2	2	3	3
JI/CDM no tech. transfer	€ 5.35	€ 0	3	5	5	5	5	5

Source: JR own calculations, Kletzan et al.(2005), Karner et al.(2005)

By way of illustration for the cases presented here, particulate matter alone was chosen to typify pollutant-induced damage to the environment, but there is nothing to prevent a large number of pollutants being considered. Taking only one pollutant into consideration also means that for the cases analysed here pollutant avoidance has no impact whatsoever in terms of the policy rankings. As far as considerations on the most suitable form of electricity production are concerned, a β value of 2.5 reveals that biomass is strongly preferred to wind power. This stems from the fact that the former energy source creates far higher domestic value added than the latter. As the preference for environmental policy goals compared to economic factors rises, a shift towards wind power takes place since this allows for policies which promote zero-emission electricity generation.

5 Conclusions

The foregoing observations indicate that the promotion of biomass for heat and power production is the most efficient climate mitigation policy using public funds in this example. However, two major challenges remain in this respect. First, the need to overcome rising scarcity of biomass fuel sources (wood chips, pellets etc) by promoting offsetting measures to generate increased supply. Second, the need to reduce particulate emissions to a standardized low level by implementing suitable policies on filter equipment.

Extension of the database for the policy tool described here to take further economic and environmental impacts into account is considered desirable. It could contribute significantly to a more precise and richer analysis of national climate policies under consideration of domestic co-effects.

In further developing the policy tool, it would also be both important and desirable to take account of the fact that climate policy will become more attractive as greater use leads to economies of scale. In the same vein, the need to pay greater attention to transport policies must also be mentioned, since under certain circumstances greater savings of pollutants and greenhouse gases are to be expected in this area than in the energy sector.

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