

Review and evaluation of policy instruments for “Boosting Bioenergy in Europe”

Julia Hansson^{*} and Thomas Sterner^{}**

^{*}Physical Resource Theory, Department of Energy and Environment, Chalmers
University of Technology, SE-412 96 Göteborg, Sweden.

E-mail address: julia.hansson@chalmers.se

^{**}Department of Economics, University of Gothenburg, Box 640, SE-405 30 Göteborg/
Sterner Miljö och Ekonomi HB, Kungshöjdsgatan 11B, SE-411 20 Göteborg, Sweden.

E-mail address: thomas.sterner@economics.gu.se

Oct-Nov, 2006

SUMMARY

This report contains a review and analysis of the policy instruments discussed in the project Boosting Bioenergy in Europe (a task assigned to the authors by the Swedish Bioenergy Association – Svebio). There are two major market failures that motivate policies for renewable energy sources in general: (i) environmental externalities in the form of CO₂ emissions as well as other pollutants and (ii) insufficient investments in research and other activities aiming at finding solutions to the climate change problem as well as a need for support for market introduction for these alternatives. In addition there are possible market failures related to security of energy supply but the impact of these is debated from an economic point of view. The primary aim of most policies addressing bioenergy should be a cost-effective reduction of CO₂ emissions. Setting specific bioenergy targets will help to reach climate targets but not necessarily in the most cost effective manner.

General CO₂ taxes levied at the global level or equivalent permit systems are the best policy option from a basic economic theory point of view (in combination with support to R&D and market introduction). Since a global introduction of the first best option of policy instrument presently lack unison support, other alternative policies promoting alternative energy sources need to be considered. Feed-in in tariffs and certificate systems have similar although slightly different characteristics each with some pros and cons. In both cases attention to the details is paramount. There is a need for special finance stimulating innovation, R&D and market introduction of alternatives to fossil fuels. This can either be arranged separately or integrated into schemes such as feed-in or certificate programs.

Some more specific issues mentioned within the Boosting Bioenergy in Europe have been commented and finally some recommendation is given.

1. Introduction

The main objective of the project “Boosting Bioenergy in Europe” carried out by the European Biomass Association (AEBIOM) is to present a vision for the development of bioenergy within the EU25. As part of this, the involved European national bioenergy associations have formulated targets for the national use of bioenergy in 2010. The bioenergy associations have also proposed measures and policies needed to reach the targets for an increased bioenergy use.

The purpose of this report is to review and analyse the policy instruments discussed within the project Boosting bioenergy in Europe from an economic perspective (a task assigned to the authors by the Swedish Bioenergy Association – Svebio). A theoretical judgment of the cost effectiveness of the major proposed policies for carbon dioxide (CO₂) mitigation (i.e., CO₂ and energy taxes, certificate systems and subsidies for renewable energy sources like feed-in tariffs and investment subsidies) will be performed. The relevance of the assessed policies for CO₂ emission reduction, and for reaching the proposed bioenergy targets will be discussed.

Policy design is a complicated task and combinations between different policies may easily lead to complex effects in real world economies. It is also in most cases too early to evaluate the real effects of the policies promoting bioenergy since most of them have just recently come into force or are only proposed to be implemented. It should, however be noted that there are other underlying arguments and factors than CO₂ abatement, that influence the choice and design of the proposed policies. According to the Boosting Bioenergy in Europe project the other major underlying issue for the financial policy instruments for energy related policies within the European countries relates to energy security and the aim to minimize the dependence of imported fossil fuels. Energy security constitutes a possible additional market failure and is discussed separately in Section 2.2. The employment effects due to an increased bioenergy use will be commented in Section 2.3 since this aspect is also sometimes mentioned in the bioenergy policy discussion (even though the aspect is not discussed in the Boosting Bioenergy project).

2. Motives for policies for renewable energy sources

2.1 Main economic motives

Biomass for energy is one of the renewable energy sources available for fossil fuel substitution and may thereby reduce the associated emissions of CO₂. There are two major market failures that motivate the introduction of policies promoting renewable energy sources.

- Firstly, there is the lack of internalization of the cost of environmental externalities associated with the use of fossil fuels (i.e., the effects of the emissions are not taken into account appropriately and most emitters do not pay any compensation for the damage that the emissions will cause). These costs are

Review and analysis of the policy instruments discussed in the project
Boosting Bioenergy in Europe.

in the form of climate change due to CO₂ emissions and health effects from local air pollution.^{1,2}

- Secondly, there are insufficient incentives for research aiming at finding solutions to the climate change problem caused partly by the emissions of CO₂. That insufficient research is undertaken (i.e., too little money invested in research) is due to the fact that research and development (R&D) is expensive and the firm or nation financing it *cannot be certain to obtain the whole benefit since there may be spill over effects to other firms and there might be limited possibilities to protect new technologies through patents etcetera* since the outcome in some sense might be considered a common good. This is basically similar for any important research be it into HIV or climate change. If there is a major research breakthrough leading to solutions then it is not certain that they will be “patentable”. This fact reduces the incentive to do this type of research and thus private research is undersupplied. Therefore there is a need for public R&D to support these research fields. Besides R&D new technologies also need further support for market introduction etcetera. This is usually a very costly step.

2.2 Security of energy supply

The issue of security of energy supply and possible energy supply disruptions due to the fact that the fossil fuel resource is geographically unevenly distributed and is a finite resource has received a lot of attention lately. While external environmental costs are well founded in economic market theory, externalities related to security of energy supply is more complicated. In the literature there has been a discussion concerning market failures connected to energy security (see e.g., Toman and Bohi, 1993; Nesbitt and Choi 1998).

It seem reasonable to assume that given that the actors in the energy sector are expected to assume responsibility for any future energy supply disruption they may also be expected to take all economically justified measures they can to prevent future energy shortages. Provided that the consumers and suppliers of energy are well informed about future supply risks they may be assumed to handle all such precautions well. However, energy disruption may also come as a result of war, terrorism, natural catastrophes and other events. In such extreme situations the actors would expect government interventions and it is also the government that has to take preventive action to reduce the consequences of such events. How this should be done properly is however very difficult to say.

¹ In the electricity sector there are external environmental costs associated also with the present use of nuclear power which are in the form of cancer risks and genetic damages caused by radioactive emissions from uranium mining, reactor operation and nuclear waste-processing, similar consequences from possible reactor accidents as well as future costs for nuclear waste management.

² Note also, that there may be external environmental costs of bioenergy and other renewable energy sources as well.

Review and analysis of the policy instruments discussed in the project Boosting Bioenergy in Europe.

There are mainly two costs associated with a sudden energy disruption: (i) transfer of consumer surplus and (ii) macroeconomic adjustment costs. In the case of an energy supply disruption the price of energy increases, which means that there is a transfer of welfare from importers of energy to exporters of energy. This welfare transfer should be regarded a pecuniary externality since it is perpetrated through the market mechanism and thus is not a real external effect. Since pecuniary externalities do not usually involve any cost for the global economy as a whole it generally does not call for policy intervention. However, they imply a cost for the country or region that imports energy and is therefore often included when assessing the cost of energy disruptions (Parry and Damstadter, 2003; Leiby et al, 1997). Macroeconomic adjustment costs stems from that the producers and users of energy can not adjust instantaneously to the new higher energy price (Leiby et al, 1997). If the agents on the energy market and the governments do not anticipate the total future energy supply risk there are some externalities associated with macroeconomic adjustment costs (Toman and Bohi, 1993).

Policies that promote domestically produced biomass for energy may be argued to decrease the vulnerability to sudden energy disruptions (and prevent the transfer of consumer surplus). The import of bioenergy might also have the same effect if it contributes to increase the diversity of energy sources. However, in case of a supply disruption of e.g., oil it is likely that the global demand for biofuels for transport will increase with possibly increasing prices as a consequence. If the price on biofuels for transport increases and if the imported bioenergy easily replaces the fossil fuels used, the consumer surplus is only transferred from exporters of fossil fuels to exporters of bioenergy. To what extent a development of the bioenergy sector really reduces the impact of macroeconomic adjustment costs is dependent on the short term price relationship between the bioenergy used and the energy supply that is disrupted. There is a risk that biofuels with an ability to substitute oil will not contribute to lower macroeconomic adjustment costs since the prices of these biofuels might be correlated to the oil price. Supply disruptions might paradoxically be worse in a system that is efficient and uses only small amounts of imported fossil fuel than in an inefficient system importing large quantities where immediate efficiency gains can be made by crisis awareness. Also it should be said that this type of uncertainty is best met by stockpiling rather than by fuel substitution. Altogether the geopolitical uncertainties surrounding many of the oil-producing countries are very complex and we do not know whether stability for instance in the Middle East would be enhanced or not by a lowering of the international demand for oil. Thus, the importance for security of energy supply of different bioenergy options seems to be complex and needs to be further assessed.

2.3 Employment creation from bioenergy

The employment related argument for bioenergy is based on the simple fact that an increased bioenergy use would result in a certain number of jobs. Technologies for renewable energy sources are in general more labour intensive than conventional energy technologies and bioenergy has the highest employment-creation potential (ECOTEC, 1999). Rural regions in particular can benefit from the establishment of bioenergy industries and the related production of biomass.

But could promotion of bioenergy lead to substantial employment effects in agriculture or even when considering total employment in a nation? Estimates of the employment creation potential for various bioenergy options differ substantially. However, liquid biofuels for transport based on traditional agricultural crops seem to be the most employment-intensive option, especially when the biofuel conversion plants are small. Large scale bioenergy production has the potential to contribute substantially to creating jobs in agriculture in many EU countries. But, compared to the total national employment the contribution has been estimated to be relatively small (Berndes and Hansson, 2006).

From an economic perspective the use of employment creation in nations as a rationale for energy policies for bioenergy has also been questioned (see e.g., Sterner et al., 1998). The introduction of subsidies for possibly unprofitable activities would lead to employment creation in a short term perspective but would rather have a negative effect on the long term since it will lower the productivity and thereby likely decrease the employment creation in the economy as a whole. This does not, however, exclude that positive local/regional employment effects may arise. If an activity like bioenergy results in employment creation in a region with high (or permanent) unemployment this could be positive from a regional policy perspective. However, the natural way to internalize such an effect is through a general subsidy to employment in that region, since such a subsidy would affect all the activities that generate employment in the region equally.

Despite the fact that some of the policies promoting bioenergy can be questioned from an economic perspective it is worth noticing that it seems like different policy objectives underlying the promotion of bioenergy in Europe (i.e., cost-effective climate change mitigation, reduced dependency on imported fuels and employment creation) do not agree on which bioenergy options should be used (see Berndes and Hansson, 2006 for an extended discussion). For example there is a potential conflict between maximization of climate benefits and maximization of employment creation since bioenergy options that use lignocellulosic resources are preferred from the perspective of cost-effective climate change mitigation while liquid biofuels based on traditional agricultural crops seem to be the most employment-intensive option³. Thus, there are tradeoffs that need to be addressed by policy makers promoting the use of bioenergy (i.e., should only the motives well funded in the economic literature be used as rational for policy making or should other aspects be taken into consideration and if so, to what extent). Since this report contains an economic review the policy analysis will focus on the main economic motives.

3. General policy analysis

The environmental problems caused by CO₂ emissions from fossil fuel use are independent of the sector and location of the emissions. From the perspective of an economist, the first best option of policy instruments to reduce the CO₂ emissions (i.e.,

³ Again the enthusiasm for methods that are very labour intensive is quite suspect. If the policy maker wants to enhance the well-being of the economy and high employment then techniques that are efficient and profitable should be chosen – not ones that are artificially high in labour content.

correct for the related market failures) would therefore be a CO₂ tax⁴ on fossil fuels levied at the global level or an equivalent permit systems, whereby those responsible for causing the external costs end up paying a cost to society to correct for them. This tax is preferably a Pigouvian tax which at the margin is set equal to the value of the external cost (Pigou, 1920). However, a global CO₂ tax on all use of fossil fuels seems to be politically infeasible in the foreseeable future. One of the problems is the use and control over the revenues collected although this could potentially be solved by having internationally coordinated but nationally levied taxes. Even these taxes would however be fiercely resisted and powerful lobbies will try to stop or weaken their effect. It seems also politically difficult to introduce Pigouvian environmental taxes in certain sectors e.g., the electricity sector on a national and regional level (even though they from an economic perspective might represent an efficient way of reaching optimal pollution levels (Kåberger et al., 2004)). To correct also for the market failure that there are insufficient incentives for research into new technologies we could envisage a combination of a tax on CO₂ emissions and subsidization of R&D as well as of actual conversion of energy from renewable energy sources (Fischer and Newell, 2004).

Since the first best option of policy instrument in its entirety is not feasible⁵, other alternative policies promoting alternative energy sources e.g., sector specific policies need to be considered. Since there is more than one underlying market failure a combination of policies is likely be needed (e.g., it might be necessary with subsidies for R&D to correct for the second mentioned market failure). A variety of policies have also been proposed in the Boosting Bioenergy in Europe project.

3.1 Survey of the main proposed policies

The main policies proposed for heat consists of (i) a certificate trading system for biomass or renewable heat (Germany and Belgium)⁶ and (ii) subsidies for heat produced from biomass or other renewable energy sources (Finland, Sweden and Austria: note that both the proposed trading system⁷ and the investment subsidy in Austria is included here).

The main policies proposed for the electricity sector are (i) a green certificate system promoting the production of electricity from renewable energy sources (Bulgaria and Sweden: note that such a system has already been implemented in Sweden)) and (ii) a feed-in tariff system for renewable electricity (Austria and Germany: already implemented in both countries).

⁴ A CO₂ tax is identical to a C tax from a policy point of view. Naturally there are also permit schemes which fulfill a similar role.

⁵ The introduction of subsidies for R&D and for the use renewable energy sources might however be politically feasible.

⁶ Regarding certificate trading systems for heat, the details in policy design is paramount for the real effect if this policy instrument is chosen to be implemented and should be given careful attention (e.g., one must make sure that the policy instrument does not counteracts efficiency improvements in the system).

⁷ If the trading system with eco-heat coupons is realized one must make sure when designing the policy instrument that it does not counteracts possible efficiency improvements in the system. As it is described, there is a risk that the incentive to insulate the building instead of investing in new capacity is reduced.

In the transport sector mandatory low blending of biofuels for transport in the ordinary fossil based transport fuels has been proposed in Germany and Finland while Sweden stresses the importance of increasing the allowed level for low blending in petrol and diesel. In addition, in general for all sectors increased support for R&D has also been proposed.

3.2 General economic view on policies for climate change and renewable energy

Many kinds of policy instruments have been suggested to address the issue of climate change and related CO₂ emissions e.g., carbon taxes, fossil fuel taxes, renewable energy subsidies and portfolio standards for the carbon intensity of energy conversion as well as for the use of renewable energy sources. One of the underlying questions is: should the aim be to pull renewable energy sources or to push back the use of fossil fuel for energy purposes or both?

Fischer and Newell (2004) have analysed the relative efficiency of different policy instruments to deal with climate change issues and for the promotion of renewable energy sources. They compare six types of policy instruments: (i) a carbon tax or permit scheme, (ii) a subsidy on renewable energy sources for electricity production, (iii) a tax on fossil fuel based energy, (iv) a green certificate system where a certain percentage of the output must be based on renewable energy sources, (v) tradable emission performance standards for all sources of energy (i.e., a required ratio of energy output for every ton of CO₂ emitted, coupled with a provision that highly efficient companies could sell permits to their less efficient competitors) and finally (vi) a subsidy for R&D investment in renewable energy sources.

Also Gerlagh and van der Zwaan (2006) compare the cost-efficiency of various policy instruments that could be used to reduce the CO₂ emissions substantially. The included policy instruments are: (i) a CO₂ tax, (ii) a fossil fuel tax, (iii) a subsidy on non-fossil energy, (iv) a portfolio standard for the CO₂ emission intensity, by recycling CO₂ taxes as subsidies to non-fossil energy⁸, and (v) a portfolio standard for the non-fossil energy share, by recycling fossil fuel taxes as subsidies to non-fossil energy.

Fischer and Newell (2004) find that raising the price of CO₂ emissions is the most cost efficient way to reduce emissions (as has been mentioned earlier). Gerlagh and van der Zwaan (2006) find on the other hand, that a portfolio standard for the CO₂ emission intensity is always the cheapest option. Thus, their conclusion is that taxing CO₂ and

⁸ Gerlagh and van der Zwaan define a carbon portfolio standard as a regulation that specifies a binding carbon intensity of energy use without levying a net tax or subsidy. In modeling terms, this is equivalent to demanding that the user-price of energy is equal to the per unit production costs (without a tax wedge). In their model the portfolio standard is implemented by applying both a carbon tax and a non-carbon subsidy, but at a level such that carbon tax revenues exactly match non-carbon subsidy expenditures. They state that the result is that the net tax payments are zero and the combined tax-subsidy instrument is equivalent to a portfolio standard.

Review and analysis of the policy instruments discussed in the project
Boosting Bioenergy in Europe.

recycling the resulting revenues to the non-carbon energy resource is the most cost-efficient policy instrument to reach CO₂ emission reductions. However, they also conclude that *“imposing a carbon tax is almost always an approximately cost-effective way to reach climate change control goals and that the performance of carbon taxes becomes better the more stringent the target is”*. The difference depends on different opinions about the potential for cost decrease for renewable energy sources. The cost decrease is a result of learning but also depend on possible future siting scarcity.

Both Fischer & Newell and Gerlagh & van der Zwaan find that a tax on fossil fuels is more costly than a CO₂ tax. This depends on that the introduction of a CO₂ tax in a certain sector will affect only part of the total fossil related CO₂ emission. To achieve the same overall effect as in the case with a CO₂ tax on all fossil fuel use the new tax has to be larger. Thus, in the case with a CO₂ tax in a certain sector a disproportionately large tax is put on some fossil emissions while others is not affected. From an economic point of view this is a sign of inefficiency.

A feed-in tariff system in the electricity sector (as used in Austria and Germany and proposed to continue by the Boosting bioenergy in Europe project) could be regarded as a subsidy for renewable energy sources. According to Fischer and Newell (2004) subsidies for the use of renewable energy sources or for research regarding these sources appear as the least efficient policy instruments. The reason why a CO₂ tax is more effective than the other assessed policy instruments is it simultaneously puts pressure on consumers to use less energy and be more energy efficient and on producers to start using technologies that emits less CO₂ per energy output, and on renewable energy sources to expand. Kåberger et al., 2004 comments: *But emissions taxes are unpopular because they are visible and governments (erroneously) worry that the taxes will slow economic growth. Subsidies to renewable energy avoid burdening consumers, but they tend to be costly in terms of tax revenues foregone, and they can be significantly less effective when the goal is reducing CO₂ emissions. For these reasons it is the ineffective subsidy instrument that actually threatens economic growth more than the CO₂ tax.* Also Gerlagh and van der Zwaan agree on that subsidies directed towards renewable energy sources generally constitutes the most expensive way to control climate change, irrespective of the CO₂ stabilization target. However, they claim that subsidies for the use of non-fossil energy resources perform relatively well for loose CO₂ stabilization targets.

The aim of a green certificates system (used in Sweden and proposed in Bulgaria for electricity production) is to provide a good subsidy for renewable energy sources. Though, it will not create any incentive for energy conservation or for new more efficient fossil technologies. On this issue Kåberger et al., 2004 states that *“To achieve the same reduction in CO₂ emissions without using the natural incentive to conserve, the subsidy to renewable energy sources (represented by the green certificates) will have to be inefficiently large implying that resources are wasted.”* Kåberger et al., 2004 continues *“Note that the tradable emission performance standards are actually preferable to green certificates since they have all the flexibility of green certificates but also the additional flexibility that carbon-efficient technologies can be used (for instance coal combustion with carbon sequestration and storage)”*. In addition, Fischer and Newell conclude that a

Review and analysis of the policy instruments discussed in the project Boosting Bioenergy in Europe.

green certificate system (which creates an implicit tax on fossil energy in the form of the mandate to buy green certificates, which then funds a subsidy to renewable energy sources through the certificate value) raises the total price received by the renewable energy sector and encourages more renewable energy output and R&D than a tradable emissions performance standard or a fossil fuel tax, *but at a greater welfare cost*.

When comparing a green certificate system with a feed-in tariff system, one could argue that goal fulfilment is harder to achieve with a feed-in tariff system (this since it primarily affects the price and not directly regulates the quantity of renewable energy sources). On the other hand, a feed-in tariff system is supposed to be a more valuable support for new industries than green certificates due to that the latter is associated with uncertainties (since the future value of certificates is uncertain and hence associated with higher risk taking due to that banks are sceptical to this option). If a certificate system is chosen Kåberger et al., (2004) points out that: (i) the obligation to hold certificates should be spread as much as possible (preferably it should cover all fossil fuel users or at least as large a share of them as possible) and (ii) the technologies to be encouraged should either be as broad as possible (this implies flexibility and encourages innovation) or be targeted as narrowly as possible to certain new technologies that are known to require support in order to overcome barriers to entry or R&D barriers.

Generally speaking, both certificate systems and feed-in tariffs have some advantages. Both of these instruments can be developed and their actual properties will depend considerably on the fine details. Whether or not they benefit really new and innovative methods depends on how the criteria are written. It might appear easier to fine-tune the criteria set for feed-in tariffs but in principle it would seem possible to have the same criteria (for instance only innovative and not yet commercial schemes) in a certificate program. One difference that we have not touched upon yet is how the instruments will be viewed by the EU with respect to “State Aid”. One of the advantages of the certificate scheme is that it does not involve any direct transfer of resources from the state to any industry and thus it can never be considered as state aid. Feed-in tariffs are however state aid – and although they may be permitted when there are important environmental or other goals at stake, the permission will in principle always be temporary. A further factor is that subsidies or certificate programs will generate some supporters and thus provide a counter-balancing force to the lobbies that oppose effective climate policies in general. In fact it could very well be subsidies for new sustainable technology that is the best (second-best) policy instrument available (see e.g., Newell and Fischer, 2004).

The conclusion is that the appropriateness of policy instruments in a certain country or sector (given that the first best solution is infeasible) depends on the specific situation and circumstances e.g., on what other policy instruments that are present.

3.3 The real purpose of the proposed bioenergy targets and policies

It should be noted that, from an economic point of view, some of the policies proposed in the Boosting bioenergy in Europe (e.g., mandatory targets for biofuels for transport) project can be considered to aim at reaching subgoals since they are primarily intended to

Review and analysis of the policy instruments discussed in the project
Boosting Bioenergy in Europe.

meet a certain amount of bioenergy use in different sectors instead of an efficient reduction of CO₂ emission (which is the main economic motive behind policies for bioenergy and other renewable energy sources). Setting specific bioenergy targets will help to reach climate targets but not necessarily in the most cost effective manner since options like increased energy efficiency or wind power, with the potential to meet the climate goal at a lower cost, are not included. Unwise policy in the field of bioenergy may also stimulate expansion of certain bioenergy options that might negatively affect other more efficient bioenergy options. This might be the case for targets promoting biofuels for transport, which tend to stimulate biofuels for transport offering rather low climate benefits. If such targets are ambitious, the development of lignocellulosic crops production (for heat/power and eventually biofuels for transport) may be hampered (since farmers get new markets for their traditional crops). This can lead to that the stationary sector may have to face challenges of biomass scarcity (restricted to forest biomass and agricultural residues) that forces them to more costly CO₂ emissions reduction options.

It is also highly important to stress what the real purpose of the target is, in this case: is it to increase the bioenergy use in general or is to support biomass use with a high efficiency rate and high reduction in CO₂ emissions? The latter is stated as a general rule for financial instruments in the Boosting bioenergy in Europe project. However, when policies are proposed on a national level this discussion is missing and the policies are not related the biomass resources available. In a short term this might not be a large problem but the policies chosen might remain for a longer period than the proposed targets. Thus, this aspect needs to be taken into consideration.

If the main target with the proposed policies should not be considered to be CO₂ reduction but instead to increase the use of bioenergy, it should be noted that, in theory, all kind of polices could be used to boost bioenergy to a very high level - if they are designed for this purpose. But which policies boost bioenergy most cost-effectively? This is a more complex question from a theoretical economical perspective since it depends on the actual design, if, and how, the policies are combined and the contribution from other factors present in the society. To discuss the real effect of a specific policy instrument before or even after it has been implemented is difficult since the societal context where it applies is complex and there are many different factors besides the actual policy that might influence the outcome. Thus, the bioenergy use before and after the introduction of a certain policy has to be investigated and related to other changes with potential impact.

3.4 Harmonisation of European bioenergy policies?

Since there are different conditions what regards bioenergy in the European countries it seems reasonable to have different policy ambitions in different countries. However, the importance of more general policy instruments should not be neglected. Different conditions with regard to bioenergy (and many other variables of interest) do indeed imply that the expected penetration of bioenergy into the market will vary significantly. It is natural that there will be a higher bioenergy share in Sweden or Finland than in Luxemburg or the Benelux countries (unless they start to import very large amounts of biofuels). However, this conclusion does not necessarily carry over in any direct or

Review and analysis of the policy instruments discussed in the project
Boosting Bioenergy in Europe.

simple way to the choice of policy instruments. In fact that is one of the advantages of a policy instrument like a tax or subsidy that the political decision maker does *not* have to decide on all the physical quantities. In a very simplified model it would indeed be optimal to have one single carbon tax across the whole world - and it would then lead to very different amounts of fossil and bioenergy use in different countries. To argue that country heterogeneity creates a need for differentiation of the policy instruments themselves is something somewhat more complex and the case is less clear cut but this does not preclude completely the possibility that different instruments should be used. An example of this is that market based instruments such as taxes carry greater advantages in big and complex economies with many sectors and highly varying marginal costs than in small economies where sometimes simpler policy instruments may be preferable.

3.5 Combination of policy instruments

In real life there is sometimes a need for a combination of policies in order to correct for market failures. There are several policies that can be combined. A tax and a subsidy can be combined. This combination can also be combined with feed-in tariffs, a green certificate system and/or a demand for a certain share of renewable energy. Emission permits can be combined with a tax (but in this case the effect on CO₂ emissions depend in principle on the system for emission permits). If the CO₂ tax is complemented with a subsidy for bioenergy the effect is more bioenergy (and potentially more renewable energy in total given that the subsidy is large enough).

If a subsidy for renewable energy or bioenergy specifically is introduced where there already is a quota system (e.g., prescribing the maximal amount of allowed CO₂ emissions) the emissions of CO₂ will in principle not decrease any further due to the subsidy since the amount of CO₂ emissions is already given by the quota system. The same effect is valid if the quota represents a compulsory amount of renewable energy i.e., a subsidy will in practice not result in an additional contribution of renewable energy. This is true unless the subsidy is large enough to make the quota system redundant. In real life, decision on policies are often made step by step, e.g., if a CO₂ tax is introduced and turns out to be too low it can later be complemented by a subsidy for bioenergy. A quota system that is applied and found to be too generous (which is the effect of e.g., an overestimation of the difficulties related to CO₂ emission reduction) can not be complemented the same way (i.e., by a subsidy) and is thus more difficult to adjust afterwards.

Finally it should be pointed out that the political economy of policy instrument combinations may change with the instruments. It sometimes appears that politicians have a piecemeal approach to taxation: They hesitate to raise a tax very drastically but raise it incrementally. When for instance a carbon tax has been set at a low level and the politicians realize it is a rather low level, they can so to speak complement this policy by a subsidy on e.g., biofuels. The point we want to make here is that this process works reasonably in the sense that the subsidy on biofuels is additive with and thus complementary to the tax on carbon. When politicians are using a tradeable permit for carbon however, this piecemeal approach does not work well. If the permit policy is too

lax (which implies in this context too large a number of permits issued) then this error cannot be rectified in a simple manner by a subsidy on biofuels since this policy will have zero effect on carbon emissions and only redistributive effects within the permit scheme.

3.6 Long-term perspectives versus flexibility

Long-term perspectives are needed for many policies to function properly in practice. This since project developers and financial bodies need to reduce their risks for high investments. However, policies do also need to be flexible in time since it is important to be able to adapt to new knowledge. One example is to use emission permits or quotas but still keep the possibility to regulate the total emission target i.e., to decrease the value on the emission permits or quotas if it is found that a more stringent CO₂ emission reduction target is required.

It can also be the case that we have to change our view on which policies that are most preferable as a response to new situations. For example, at the moment a general boost of bioenergy for all applications might seem reasonable since it results in CO₂ emission reductions. However, if the competition for the available biomass resource increases the general bioenergy push should be changed and support only biomass use with a high efficiency rate and high reduction in CO₂ emissions. In addition some policies might be needed initially or temporary to support a certain bioenergy technology and help remove possible barriers but should then be removed when no longer necessary (e.g., policies stimulating co-firing of biomass and coal for electricity and heat production).

3.7 An efficient use of bioenergy – the role of biofuels for transport

The impact of different bioenergy options for climate change mitigation has been investigated by several research groups. From the perspective of greenhouse gas emissions reductions, well-to-wheel studies of alternative transport fuels find that biofuels that are produced from lignocellulosic feedstocks are preferable to biofuels from traditional agricultural crops such as cereals, sugar beet and rape seed (VIEWLS, 2005; EC/JRC, 2006). Studies that separately assess the effects of substituting fossil fuels with biomass in different applications indicate that substituting biomass for fossil fuels in heat and electricity production in general is less costly and provides larger CO₂ emissions reduction per unit of biomass than substituting biomass for gasoline (or diesel) in the transport sector (Gustavsson et al., 1995; Kågeson, 2001). Also energy system model-based studies of the relative cost-effectiveness of bioenergy options in the different sectors in the context of CO₂ emission reduction targets indicate that the use of biofuels for transport is not a cost-effective strategy and draw the conclusion that biomass should be used for heat generation and/or co-generation rather than in the transportation sector (Azar et al., 2003; Berndes and Hansson, 2006).

However, there are economic arguments in favour of biofuels for transport (i.e., arguments against having the same cost for CO₂ reduction in all sectors which the energy system model based studies above assume) which represent aspects not taken into consideration in the above studies whose outcome are only valid given certain

assumptions. Firstly, there is the importance of development and diffusion of technology and knowledge. Secondly, the industry (e.g., the electricity sector) is exposed to international competition which makes it easier, politically and nationally, to impose policies within the transport sector. Thus, biofuels for transport might represent a politically feasible option. Thirdly, there is a high willingness to pay for services in the transport sector which can be considered as luxury goods. The Boosting bioenergy in Europe project would gain from an extended discussion on the importance of different bioenergy options.

4 Policy analysis of specific issues

4.1 Reduction in VAT rates on bioenergy

As lobbyists we might argue in favour of lowering all taxes on the things we favour. As researchers this approach is not sufficiently stringent. The ideal instrument is according to economic theory a global CO₂ tax. When such a tax is infeasible, then in some cases subsidies for bioenergy may be a very good second best instrument. *If* the correct subsidy level has been set then there would be no reason not to apply standard VAT levels. It is only if the appropriate subsidies are insufficient that they might be complemented with or replaced by a lowering of the VAT. It may well be the case that some countries have lowered their VAT for biofuels because they found this simpler than giving subsidies. This may in fact be a reasonable policy in some countries, given institutional and other constraints for instance concerning the political economy of instrument selection. This can however not be made into an argument for always applying lower VAT to bioenergy in all countries.

4.2 The European Emission Trading Scheme

From an overall economic perspective an emission trading scheme should include all the emitting actors. Thus, the request from AEBIOM to make also small bioenergy applications (i.e., below 20 MW) eligible (or at least not discriminated) under the European Emission Trading Scheme seem reasonable. However, in practice the inclusion of also small facilities is likely associated with high transaction costs. This has to be taken into consideration.

4.3 The AEBIOM proposal: A flexible carbon dioxide fee/tax system in Europe

The AEBIOM proposal for an advanced support scheme essentially builds on a combination of a tax and a Refunded emission payment scheme, (REP) (see Fredriksson and Sterner, 2005; Sterner and Isaksson, 2006). The central idea of the REP is that a charge is levied on the emission (in this case carbon or CO₂) and then refunded to the producers in proportion to useful production (in this case energy). This creates incentives for low emissions of carbon in relation to energy use. It thus acts as an instrument to change the technology used in energy production.

Review and analysis of the policy instruments discussed in the project
Boosting Bioenergy in Europe.

In this particular case one would need to consider a number of details in the scheme such as the weight given to heat compared to electricity in the refund part. The solution of giving electricity twice as much as heat is of course "roughly" reasonable but somewhat arbitrary. In fact the measurement of heat produced and used can also cause problems of definition - not least in for instance transports. Then it is also the issue of other renewable energy sources than bioenergy; should these be included as well and get refund. Fossil fuels that are used in industries for other purposes than heat and electricity production, e.g., coal in the steel industry, also have to be taken into consideration. These are however questions that can be refined and dealt with in a reasonable manner. One should also consider if there are differences between a CO₂ emitting system and other systems that have refunded emission payment schemes (e.g., NO_x in Sweden).

An issue of greater importance is that a REP of this kind provides no incentive for efficient use of energy at the demand side. It is presumably for this reason that the AEBIOM proposal suggests a combination of an REP and an energy tax. The proposal is however not well explained in its details. It is for instance very unfortunate that the tax is referred to as a "fiscal" tax since this term is usually reserved for taxes that have little or no steering effect. The proposal does however (wisely enough) envisage a steering effect! Thus the suggestion is basically sound but the text should be somewhat modified here. The words "fiscal" and "national" in the text are unnecessary and confusing. The tax should *not* be set in relation to the need for fiscal revenue!

Another somewhat confusing point is that the whole concept is presented as a combination of a tax and an REP which in turn is a tax with a refund (note that the use of the word refund is preferable to deduction). In figure 53 (which gives a graphic description of the proposed policy system) the reader will note that the refund "D" and the tax "FT" might roughly cancel out - at least if they also in reality happen to be of the same size - and that would simply leave us with a straight carbon tax! To put this differently, it is a little unnecessary to present this scheme as first subsidizing electricity and heat (in "D") and then taxing electricity and heat (in "FT").

These complications can be avoided by presenting this as a Partially refunded emission payment scheme. Thus, there is a tax on CO₂ and *parts of* the tax revenue are refunded to the producers in proportion to energy (the rest corresponds to the tax in the AEBIOM proposal). This scheme is basically the same as that suggested by AEBIOM (but with a somewhat different presentation) and has the advantage of being clearer and to be more in line with the literature in this area (see Gersbach and Requate, 2004; Sterner and Isaksson, 2006).

It should also be noted that the Partially refunded emission payment scheme is closely related to allocating a share of the permits in a permit scheme free of charge and letting the participants buy the rest. Also this scheme has been suggested in the literature and it has been shown that it suffices with a fairly small percentage of free permits (or refunds) to compensate for the competitive effects of the tax (e.g., Burtraw, 2006). One of the advantages of the Partially refunded emission payment scheme is that the percentage of refunding can be varied over time. It can be high initially (to dampen political resistance

and fears of job loss) and it can be reduced as other countries introduce similar or other effective instruments. It will then gradually transform into an optimal carbon tax. It can also vary by sector so that sectors open to competition have higher percentage refunding.

4.4 The green certificate system in the Swedish electricity sector

The economic efficiency of compulsory green electricity quotas in Sweden has been analysed in Kåberger et al., 2004. It was concluded that:

“If the objective is to bring small-scale cogeneration from biomass, integrated biomass gasification combined cycle electricity generation (IBGCC), wind-power and solar electricity down the learning curve, into commercial operation additional measures are required. A system of differentiated, long-term feed-in price contracts would be more appropriate than the certificate system. Such contracts could match the significantly different needs of the different technologies and could be developed to drive development by reducing the prices for every new generation of electricity plants built. Such a system may still be run outside the state budget, while financed by all electricity customers in proportion to the amount of electricity consumed.”

However, it is true that the use of biomass in the Swedish electricity sector has increased substantially during the last years. In 2003 the amount of biofuels used in the Swedish electricity sector amounted to 5.7 TWh, in 2005 it contributed to more than half of the 12.9 TWh of electricity from combustion technologies (STEM, 2003; STEM 2005). One could also criticise the green certificate system in Sweden since a large share of the support has gone to technologies that are already profitable (such as CHP using bioenergy) rather than to the marginal technologies such as wind (and solar) that need the support and where the potential for future cost reductions are large.

The Swedish Energy Agency has not presented any official evaluations of the green certificate system but in June 2006 the Swedish government decided to develop the green certificate system further. The decision implies several changes of the system and the aim is to give it a more long-term perspective and increase the level of ambition for the renewable electricity production. The changes imply e.g., that the target level for additional renewable electricity is increased to 17 TWh in 2016 compared to the level in 2002, that the system is prolonged until 2030, that quotas will be decided as far as 2030 and that the time for allocation will be restricted. The changes to the certificate system will come into force in January 2007 (read more on www.stem.se).

5 Conclusions

The choice of policies and policy design is a complicated task since a real economy is complex. However, some general conclusions can be made. General CO₂ taxes or equivalent permit systems are the best policy option from a basic economic theory point of view (in combination with support to R&D and market introduction since a tax would not provide sufficient incentives for this). In as far as these CO₂ taxes etcetera are practically infeasible or insufficient (since implemented unwisely) in order to correct for

Review and analysis of the policy instruments discussed in the project
Boosting Bioenergy in Europe.

the associated environmental externalities and lack of research incentives, they can be complemented by subsidies or other policies for desirable alternatives including bioenergy. Such policies should in general be broad based and non-discriminatory, that is they should apply to a range of renewable or bioenergy options and should favour several technologies. Subsidies or other public support may be financed through CO₂ taxes if this policy is used⁹. This financing can either be a separate arrangement or directly arranged as a partial refunding emission payment scheme.

Feed-in tariffs and certificate systems have similar although slightly different characteristics each with some pros and cons. In both cases attention to the details in policy design is paramount for the real effect of the chosen instrument. In general (i.e., also in the case with a CO₂ tax) there is a need for special finance stimulating innovation, R&D and market introduction of alternatives to the fossil fuels. This can either be arranged separately or integrated into schemes such as feed-in tariffs or certificate programs. In either system it is possible to specifically favour the new and promising technologies which are most negatively affected by the disincentive to research that is caused by the failure to fully protect research results from being copied or from spill-over and by problems related to market introduction. In general policy makers also have a responsibility in balancing interest for specific bioenergy and other renewable energy options and technologies if some groups grow to become very strong (e.g., as a response to the implementation of related policies) .

Finally, it should be stressed that policies promoting bioenergy should in general aim at an energy efficient use of bioenergy resources. This could be achieved by a tax on CO₂ emissions which will likely result in a larger share of biomass in industrial and heating applications than in the transport sector (see e.g., the development in Sweden).

5.1 Recommendations

- Strive at implementing adequate CO₂ taxes or equivalent permit systems (e.g., cap and trade systems) since these represent the best policy option from a basic economic theory point of view
- Supplement the CO₂ taxes or equivalent permit systems with support to innovation, R&D and market introduction of alternatives to fossil fuels.
- Given that CO₂ taxes etcetera are practically infeasible or not adequately implemented other policy instruments should be considered.
- Regardless of policies chosen (e.g., feed-in tariffs and certificate systems which have similar although slightly different characteristics each with some pros and cons.), attention to the details in policy design as well as possible impact from other policies is paramount for the real effect of the chosen instrument. Thus,

⁹ It should though be noted that a CO₂ tax have the potential to bring in an extensive amount of money, and that the allocation of this might be complicated.

Review and analysis of the policy instruments discussed in the project
Boosting Bioenergy in Europe.

there is a need for a careful impact assessment of the proposed policies before implementation.

- The commission should urge the member states (MS) to broadly explore strategies for attaining the bioenergy objectives communicated in policy documents and provide for cost-effective compliance e.g., via inter-MS burden sharing mechanisms. This since the bioenergy options and prospects to meet the objectives differ between the MS.

Acknowledgments

We would like to thank our colleagues Christian Azar, Göran Berndes, Fredrik Hedenus and Karl Jonasson for useful contributions and comments. Thanks also to the authors of Kåberger et al., 2004 on which some sections of this report draw extensively.

References

Azar, C., Lindgren, K., Andersson, B.A., 2003. Global energy scenarios meeting stringent CO₂ constraints - cost-effective fuel choices in the transportation sector. *Energy Policy* 31(10), pp. 961-976.

Berndes, G., and Hansson, J., 2006. Bioenergy expansion in the EU: cost-effective climate change mitigation, employment creation and reduced dependency on imported fuels. Submitted for publication in *Energy Policy*.

Bohi, D.R., and Toman, M.A., 1993. Energy security: externalities and policies, *Energy Policy*, 21(11), pp. 1093-1109.

Burtraw, D., Kahn, D., and Palmer, K., 2006. CO₂ allowance allocation in the regional greenhouse gas initiative and the effect on electricity investors. *The Electricity Journal*, March 2006.

ECOTEC, 1999. The impact of renewables on employment and economic growth. EC Project initiated by EUFORES and coordinated by ECOTEC Research and Consulting Ltd. ALTENER Project 4.1030/E/97-009.

European Commission / Joint Research Centre (EC/JRC), 2006. Well-to-wheels analysis of future automotive fuels and powertrains in the European context. CONCAVE/EUCAR Well-to-wheels report, version 2b, May 2006.

Fischer, C., and Newell, R., 2004. Environmental and technology policies for climate change and renewable energy. Resources for the future. Discussion paper 04-05, April. Available at: <http://www.rff.org/rff/documents/RFF-DP-04-05.pdf>

Review and analysis of the policy instruments discussed in the project
Boosting Bioenergy in Europe.

- Fredriksson, P.G., and Sterner, T., 2005. The Political Economy of Refunded Emission Payments, *Economic Letters*, 87(1), pp. 113-119.
- Gerlagh, R., and van der Zwaan, B., 2006. Options and instruments for a deep cut in CO₂ emissions: Carbon dioxide capture or renewables, taxes or subsidies? *The Energy Journal*, 27(3), pp. 25-48
- Gersbach, H., and Requate, T., 2004. Emission Taxes and Optimal Refunding Schemes, *Journal of Public Economics*, 88 (3-4), pp. 713-725.
- Gustavsson, L., Börjesson, P., Johansson, B., Svenningsson, P., 1995. Reducing CO₂ emissions by substituting biomass for fossil fuels. *Energy*, 20, pp. 1097-1113.
- Kåberger, T., Sterner, T., Zamanian, M., and Jürgensen, A., 2004. Economic efficiency of compulsory green electricity quotas in Sweden, *Energy & Environment*, 15(4), pp. 675-697.
- Kågeson, P., 2001. The impact of CO₂ emissions trading on the European Transport Sector. Vinnova report VR 2001:17, Sweden.
- Leiby, P.N., Jones, D.W., Curlee, T.R., Lee, R., 1997. Oil imports: An assessment of benefits and costs. Oak Ridge National Laboratory, November 1997.
- Nesbitt, D.M., Choi, T.Y., 1998. Is an oil tariff justified? An American debate: The numbers says no. *The Energy Journal* 9(3), pp. 21-50.
- Parry, I.W.H., and Damstadter, J., 2003. The costs of US Oil Dependency. Resources for the future, Report 03-59.
- Pigou, A.C., 1920. *The Economics of Welfare*. 4th ed. London: MacMillan.
- Statens Energimyndighet (STEM), 2005. Energiläget 2005, ET 23:2005, Swedish Energy Agency (in Swedish).
- Statens Energimyndighet (STEM), 2004. Energiläget i siffror 2004, ET 18:2004, Swedish Energy Agency (in Swedish).
- Sterner, T., and Isaksson, L.H., 2006. Refunded Emission Payments -a hybrid instrument with some attractive properties, *Ecological Economics*, 57(1), pp. 93-106.
- Sterner, T., Johansson, B., Johansson-Stenman, O., 1998. Skall vi köra på sprit? (Should we use alcohol as fuel for vehicles?), *Ekonomisk Debatt*, 26(8), pp. 603-616, in Swedish.
- VIEWLS, 2005. Shift gear to biofuels. Results and recommendations from the VIEWLS project. November 2005. Available at www.viewls.org.