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Workshop Programme:
Opportunities for renewable energy development in Europe

Venue
European Parliament - Strasbourg - 13 March 2008

Room LOW S 4.4
9.00 – 12.00

9:00 Welcome and opening – Rapporteur MEP Mr Claude TURMES

Part 1: RES Potentials and targets, new flexibility systems & efficient instruments

9:10 Presentation by **Mario Ragwitz**,
Department Energy Technology and Energy Policy,
Fraunhofer Institute Systems and Innovation Research, Karlsruhe

9:20 Debate: questions and answers session

Part 2: RES Trading as an option

9:50 Presentation by **Andreas Löschel**,
Department Environmental and Resource Economics, Environmental Management
ZEW Centre for European Economic Research, Mannheim

10:00 Debate: questions and answers session

Part 3: Biomass potentials and transformation strategies in the EU & policies for import

10:30 Presentation by **Francis Johnson**
Climate and Energy Programme
Stockholm Environment Institute

10:40 Debate: questions and answers session

Part 4: Addressing social and socio-economic impacts: biofuels sustainability criteria

11:10 Presentation by **Charlotte Opal,**
Coordinator of the roundtable on sustainable biofuels
Energy Centre of the Ecole Polytechnique Fédérale de Lausanne

11:20 Debate: questions and answers session

Conclusions

11: 50 Closing remarks – Rapporteur MEP Mr Claude Turmes and Shadow Rapporteurs

"RES Potentials and targets, new flexibility systems & efficient instruments"

by Mario Ragwitz

EXECUTIVE SUMMARY

Until now, Renewable Energy Sources (RES) support has been exclusively based on national policies, i.e. for the electricity sector in particular feed-in tariffs, quota systems and tax measures. The development of these national policies was substantially driven by the indicative national targets as set by the Directive 2001/77/EC. The instruments used in the EU Member States have shown different levels of success in promoting renewable electricity. The European Commission evaluated the different policies in an Communication in 2005 (COM(2005) 627) and in the recent Commission Staff Working Document "The support of electricity from renewable energy sources" SEC(2008) 57 accompanying the Directive proposal (COM (2008) 19), which comes to the main conclusion: "*This report presents an updated review of the performance of support schemes using the same indicators presented in the 2005 report. It finds that, as in 2005, well-adapted feed in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity.*"

With the European Commission proposal for a directive on the promotion of the use of renewable energy sources (COM (2008) 19) a new, more flexible policy design is being discussed by EU policy makers against the background of setting Member State (MS) targets for the year 2020. Following the Directive proposal the EU target is allocated to differentiated national targets based on a flat rate approach (same additional share for each country) modulated by the MS GDP. Such an approach of target allocation does not reflect the resource availability of the countries and therefore does not allow for a least cost exploitation of the European potentials. Therefore several flexibility measures to better map targets and potentials are currently discussed.

Policy makers are looking for the right balance between the introduction of MS flexibility in order to enhance efficient resource exploitation, and the continuation of national instruments in order to not disrupt currently successful instruments by superimposing a harmonized system that may or may not be optimally designed. The main approach presently suggested within the renewable energy Directive for the introduction of flexibility regarding the MS target achievement, is a European wide trading scheme for renewable electricity. this comprises a virtual trading scheme by means of guarantees of origin (GO), independent from physical integration or exchange. The proposal of the RES Directive introduces two ways to establish such trade – i.e. (1) solely between governments or (2) by including private parties, i.e. RE producers and utilities obliged to buy RE under a quota obligation.

This report first discusses the past experiences with policies for renewable electricity. Then it elaborates on the main motivation to introduce a new flexibility mechanism. In a further step it analyses the economic implications of the proposed trade between private parties, assuming that this trade cannot be effectively restricted by MS. In the main part the three most relevant options to establish flexibility are introduced, and advantages and drawbacks are discussed. The report comes to the main conclusion that flexibility should be introduced between governments instead of private market participants. The main reasons are based on the fact that flexibility between governments leads to lower overall policy costs, better chances for target compliance and less negative impacts on existing national support schemes.

1. ECONOMICS OF RENEWABLE ENERGY SOURCES AND POLICY OPTIONS

1.1 Economics of investments in renewable energy

Renewable energy sources are typically characterised by a high level of fix costs due to high investment costs and low variable cots due to low fuel costs (exceptions from this rule are some biomass technologies). This statement is visualised in Figure 1 and Figure 2, where the long run marginal costs as well as the short run marginal costs for renewable electricity technologies are shown. Whereas the long run marginal costs include the investment as well as all variable costs, the short run marginal costs only include the variable costs of a technology. It can be clearly observed that key technologies such as wind energy, hydro power, landfill gas and solar energy are characterised by high investments and low running costs. Due to this fact it is of utmost importance for the development of renewable energy sources to minimise the risk for an investment based on a stable and continuous policy framework. Despite the fact that investment security is also important for conventional energy sources, it is much more relevant for renewable energy sources due to the very little influence on the generation costs during the operation of the plant.

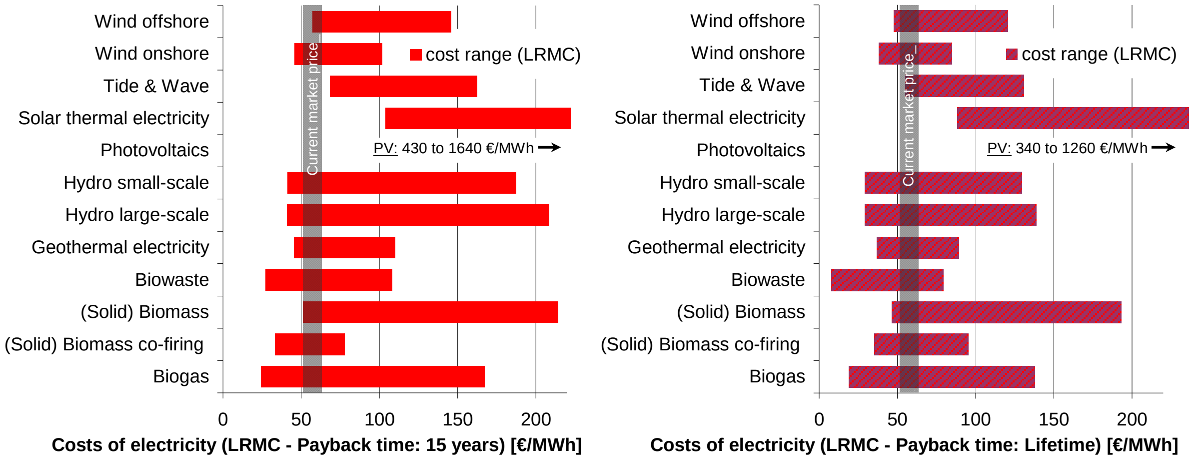

Figure 1: Long run marginal cost of renewable electricity technologies

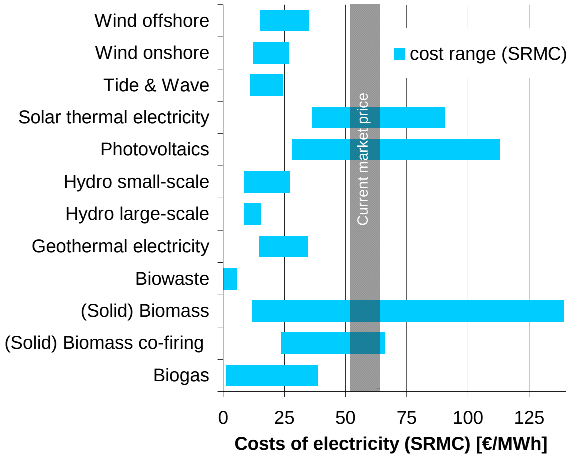

Figure 2: Short run marginal cost of renewable electricity technologies

1.2 Past experience with policies for renewable electricity

Within this study, the assessment of direct regulatory promotion strategies is carried out by focussing on the comparison between price-driven (e.g. Feed in Tariffs) and quantity-driven (e.g. Tradable Green Certificate-based quotas) strategies, which can be defined as follows:

Feed-in tariffs (FITs) are generation-based, price-driven incentives. The price that a utility or supplier or grid operator is legally obligated to pay for a unit of electricity from RES producers (RES-E) is determined by the system. Thus, a federal (or regional) government regulates the tariff rate. It usually takes the form of either a fixed amount of money paid for RES-E production, or an additional premium on top of the electricity market price paid to RES-E producers. Besides the level of the tariff, its guaranteed duration represents an important parameter when evaluating the actual financial incentive. FITs allow technology-specific promotion and acknowledge future cost-reductions by applying dynamically decreasing tariffs.

Quota obligations based on Tradable Green Certificates (TGCs) are generation-based, quantity-driven instruments. The government defines targets for RES-E deployment and obliges a particular party of the electricity supply-chain (e.g. generator, wholesaler or consumer) with their fulfilment. Once defined, a parallel market for renewable energy certificates is established and their price is set following demand and supply conditions (forced by the obligation). Hence, for RES-E producers, financial support may arise from selling certificates in addition to the revenues from selling electricity on the power market. In principle, technology-specific promotion is also possible in TGC systems. But it should be noted that separate markets for different technologies will lead to much smaller and less liquid markets.

Figure 3 shows the evolution of the main support instrument for each country of the EU-25. Only 8 of the 25 countries regarded did not experience a major policy shift during the period 1997-2006. The current discussion within EU Member States focuses on the comparison of two opposed systems, the FIT system and the quota regulation in combination with a TGC-market. The latter have replaced existing policy instruments in some European countries such as Belgium, Italy, Sweden, the UK, Poland and Romania. Other policy instruments such as tender schemes are no longer used in any European country as the dominating policy scheme. However, there are instruments like production tax incentives and investment incentives which are frequently used as supplementary instruments. Only Finland and Malta apply them as their main support scheme.

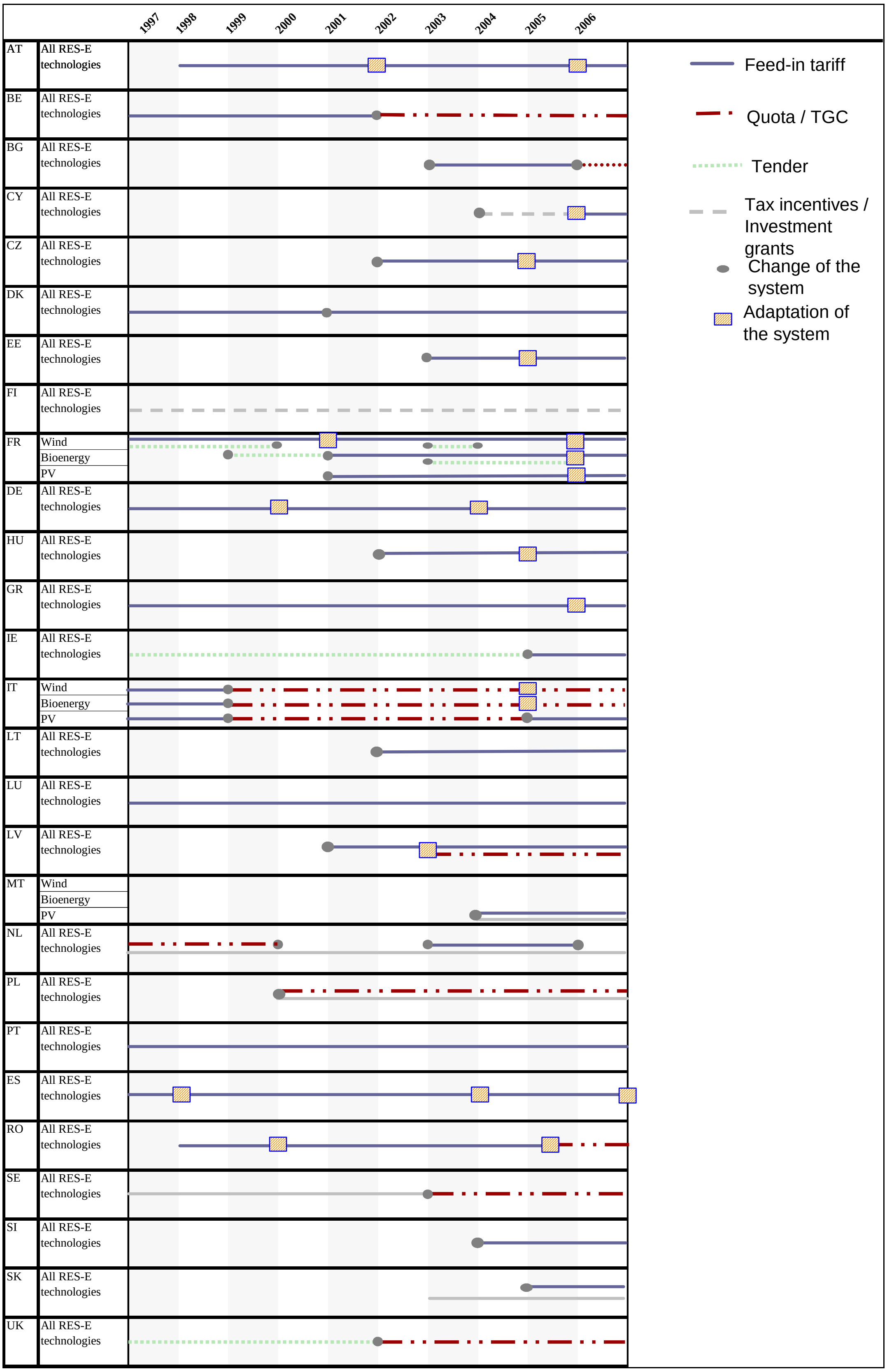

Figure 3. Evolution of the main policy support schemes in EU-15 Member States

This section discusses the effectiveness of a policy to increase the generation from renewable electricity. The definition of effectiveness used in this analysis is given in equation (1).

$$E_n^i = \frac{G_n^i - G_{n-1}^i}{ADD - POT_n^i} \qquad (1)$$

E_n^i	Effectiveness indicator for RES technology i for the year n
G_n^i	Existing normalised electricity generation by RES technology i in year n
$ADD - POT_n^i$	Additional generation potential of RES technology i in year n until 2020

This definition of effectiveness has the advantage of being unbiased with regard to the available potential for individual technologies in a specific country. Member States need to deploy RES-E-capacities proportional to the given potential in order to demonstrate the comparable effectiveness of their instruments. This appears to be a meaningful approach since the Member State targets, as determined in the Directive 2001/77/EC, are also mainly based on the realisable generation potential of each country.

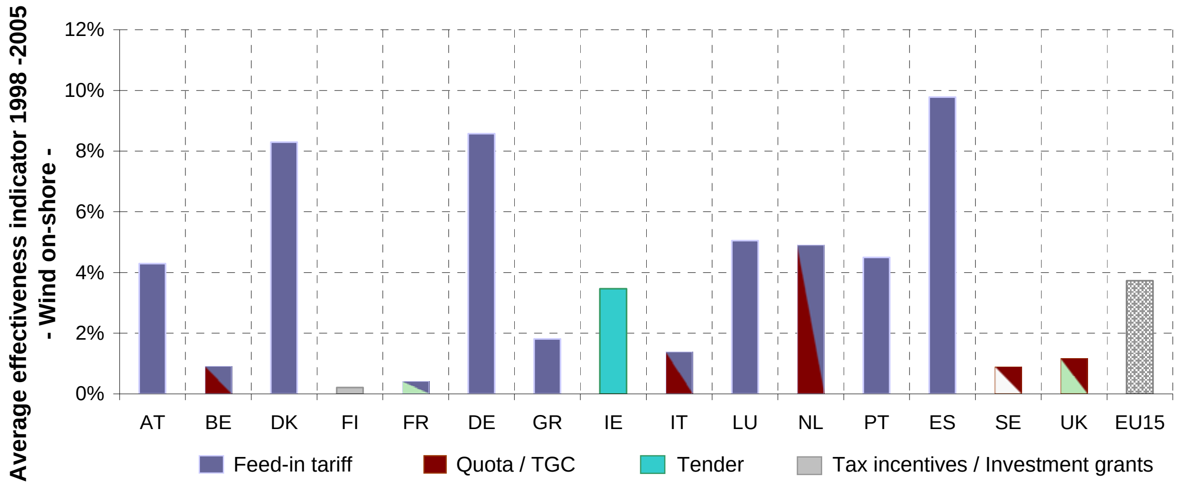

Figure 4. Effectiveness indicator for wind onshore electricity in the period 1998-2005 in the EU-15 showing the relevant policy schemes during this period

Figure 4 shows the average annual effectiveness indicator for wind onshore electricity generation for 1998-2005 for EU-15 countries. Several findings can be derived from these figures. Firstly, the three Member States showing the highest effectiveness during the considered period, Demark, Germany, and Spain, applied fixed feed-in tariffs during the entire period 1998-2005 (with a relevant system change in Denmark in 2001). The resulting high investment security as well as low administrative barriers stimulated a strong and continuous growth in wind energy during the last decade. It is often claimed that the high level of the feed-in tariffs is the main driver for investments in wind energy, especially in Spain and Germany. However, as will be shown in the next paragraph, the tariff level is not particularly high in these two countries compared with other countries analysed here. This indicates that a long-term and stable policy environment is actually the key criterion for the success of developing RES-E markets. As can be observed in a country like France, high administrative barriers can significantly hamper the development of wind energy even under a stable policy environment combined with reasonably high feed-in tariffs.

In order to analyse the economic efficiency of support from the historical perspective we compare the level of support in the case of wind energy onshore and the corresponding costs of electricity generation. Based on this definition the analysis shows (see Figure 5) that, for many countries, the support level and the generation costs are very close. Countries with costly potentials frequently show a higher support level. A clear deviation from this rule can be found in the three quota systems in Belgium, Italy and the UK, where support is presently significantly higher than the costs of generation. The reasons for the higher support level expressed by the current green certificate prices include still immature TGC markets, the non technology-specific design of the currently applied TGC-systems as well as the higher risk premium requested by investors. In the case of Spain and Germany, the support level indicated in Figure 5 appears to be above the average level of generation costs. However, the low cost potentials have already been exploited in these countries due to the recent successful market growth. Therefore a level of support that is moderately higher than average costs seems to be reasonable.

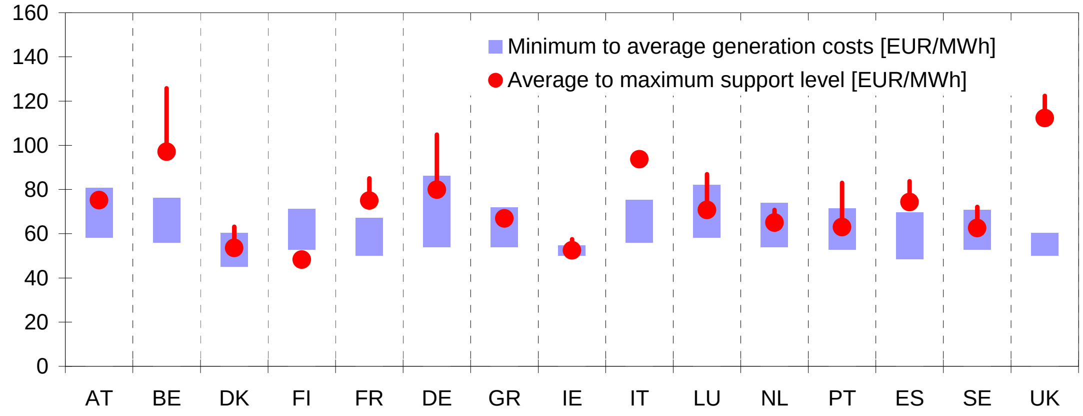

Figure 5. Support level ranges (average to maximum support) for direct support of wind onshore in EU-15 Member States (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs)

The empirical findings presented in this chapter show that instruments which have proven to be effective also tend to be economically efficient. Feed-in systems, which are implemented in the majority of EU Member States, have initiated significant growth of renewable energy generation at moderate costs for society. The main reason for this observation is the long term price security of the system combined with technology diversification of support. Compared to short term trading in renewable certificate markets the intrinsic stability of feed-in systems appears to be a key element for success.

This finding was also expressed by the European Commission in the Commission Staff Working Document "The support of electricity from renewable energy sources" SEC(2008) 57 accompanying the Directive proposal: "*This report presents an updated review of the performance of support schemes using the same indicators presented in the 2005 report. It finds that, as in 2005, well-adapted feed in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity.*"

2. FLEXIBILITY OPTIONS FOR RENEWABLE ENERGY SOURCES IN EUROPE

The European Commission presented the proposal of a new EU directive for renewable energies (RE) that sets binding targets for all EU Member States (MS) to reach the overall target of 20% renewable energy share in EU energy consumption by 2020, as agreed upon by the European Council in March 2007. The target sharing between MS is not based on RE potential, but on a flat rate increase per MS, adapted to the country specific GDP. Against the background of this target sharing approach, several MS call for the introduction of a flexible mechanism that allows MS with low or expensive RE potential to partly fulfil their RE target in other countries with higher RE potential and lower production costs. In addition, such a flexibility mechanism could facilitate the development of additional RE potentials in countries with relatively low RE targets in relation to their national potentials.

In principle, the proposed directive would allow for two approaches, aiming simultaneously to achieve both of the objectives (efficient use of resources and fair burden-sharing). It is intended that Member States can:

(a) trade their surplus or deficit of renewable generation at a government level. This option allows as a sub-case clustering of countries based on a common feed-in scheme or a common quota system; ***and/or***

(b) give market participants the flexibility to trade guarantees of origin in other Member States (and it is made explicit that trade in GOs may take place independently of physical trade in the electricity generated).

This chapter is structured in the following manner. First the key motivations for increasing flexibility between Member States are discussed. Next the potential drawbacks of a uniform certificate market for private market participants are discussed. Advantages and disadvantages of the different options for flexibility shall be examined in the third part. Finally the option of trade at a government level will be further elaborated as important implementation details for this alternative are left open by the Directive and still under discussion.

2.1 Motivation of flexibility - optimised resource allocation

The key motivation for increased flexibility in reaching the MS targets is based on the fact that the targets are not set according to an optimised resource allocation in Europe but based on a flat-rate, GDP modulated approach.

In the *(Annex to the) Impact Assessment (IA) of the new RES directive*[1] options of and benefits arising from a European wide GO trading scheme are prominently discussed. This also includes a quantitative estimation of the benefits arising from the proposed trading system.

> *"Introducing RES trading and achieving the RES target again cost efficiently*
> *would reduce the costs in the overall energy system by up to 8 billion € by 2020."*[2]

Thereby, as stated in a footnote this quantification results from PRIMES scenarios assuming full trade, which represents an overestimation with respect to the proposed regime.

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[1] European Commission, 2008: Commission Staff working document – Annex to the Impact Assessment (provisional) referring to the package of implementation relating to the EU's objectives on climate change and renewable energy for 2020, comprising also the Proposal for a Directive of the European Parliament of and of the Council on the promotion of use of renewable energy sources {COM(2008) X final} {SEC(2008) XX}.

[2] See page 160 in Commission Staff working document – Annex to the Impact Assessment (provisional) (European Commission, 2008).

The IA also gives explanation on the derivation of these benefits:[3]

> *"Under the "potential" option, it is assumed that the 20% renewable energy target will be fulfilled in an economic efficient manner considering resource availability wherever these occur in the EU. Thus, the scenario developed for the "potential" option estimates how the 20% target could be achieved in a low cost manner considering technology diversity and dynamic context.*
>
> *The flat rate/GDP option deviates from this principle. It follows that the cost of the policy will rise and that on this criterion, the "potential" option ranks more highly.*
>
> *In terms of costs, it is unsurprising that the move from an economic allocation based on resource potential to a flat rate allocation should generate additional costs. In the simulation used in this impact assessment this cost difference was estimated by comparing the total cost of policy implementation under the two scenarios. … the costs of achieving the RES targets exactly in the individual MS could amount to up to an extra annual €8bn by 2020.*
>
> *Such costs would be diminished by increased trade, facilitated by the creation of virtually transferable guarantees of origin …, allowing Member States to meet their targets not only through national production but also by buying cheaper production elsewhere."*

Let us have a closer look on how this figure of benefits in size of 8 billion € by 2020 was derived: Large-scale energy models such as PRIMES provide a comprehensive depiction of the whole energy sector within each EU MS. However, this broader picture allows to incorporate fewer details with regard to individual submarkets as e.g. those of an artificial RES market. The cost saving expressed in the IA possibly arise from a simplified comparison of a uniform EU-wide RES trading scheme with national RES trading systems. Thereby, it appears straightforward that high benefits would occur as in both schemes a technology-neutral support for RES would be preconditioned where support costs arise from the price as set by the marginal RES option. However, the actual situation appears much more complex as most European countries apply technology-specific RES support by means of feed-in tariffs or premium systems. Within such schemes typically highly differentiated support prices are defined in line with the national RE technology peculiarities. Consequently, the consumer expenditures (policy cost) arise from the comparison of the technology-specific deployment and corresponding support – which are in case of ambitious exploitation paths far below those arising from a simplified marginal pricing scheme. Therefore the magnitude of the impact of flexibility on the total generation costs might however be significantly lower than 8 billion €.[4]

A key question is whether the efficiency gains achieved through flexibility result into a reduction of policy costs (transfer payments) to be paid by the European costumers. The answer to this question strongly depends on the design of the flexibility option introduced. In particular a uniform trading system between market participants would result in a significant producer rents (windfall profits), which may lead to a very strong increase of policy costs. This aspect is discussed in the following section.

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[3] See page 85 in Commission Staff working document – Annex to the Impact Assessment (provisional) (European Commission, 2008).

[4] As recent modelling exams conducted with the Green-X model indicate, a uniform EU-wide market might lead to reduced generation cost in range of 2 to 3 billion € by 2020 compared to pure national solutions.

2.2 Risk of strongly increasing policy costs in a uniform trading system between private market participants

A uniform trading system between private market participants bears the risk of a significant cost increases arising from high producer profits within a uniform RES trading scheme. The financial consequences of a uniform trading system were studied in Ragwitz (2007) and are also outlined in the Impact Assessment of the Directive[5]. Next we illustrate the argumentation as stated therein.

Figure 6 illustrates generically the possible producer rents (surplus) arising from a technology-neutral support scheme for producers of renewable electricity. The violet line reflects a cost-resource curve of the additional realisable potential for renewable electricity. The whole basket of available RE technologies is clustered into several bands, indicated by their (long run) marginal generation cost and the corresponding realisable future potential. Low-cost options such as biowaste incineration, biomass co-firing or most preferable sites for wind onshore are on the left part of the merit order curve, followed by moderate RES-E options – e.g. wind onshore at moderate sites, wind offshore, small-scale hydropower or large-scale biomass plants. On the margin with regard to the required additional RES-E deployment up to 2020 are large-scale agricultural biogas and medium-range biomass plants. Consequently, a mandatory technology-neutral GO trading scheme is expected to result in significant producer rents, which are shown in Figure 6 as the violet area above the cost-resource curve.

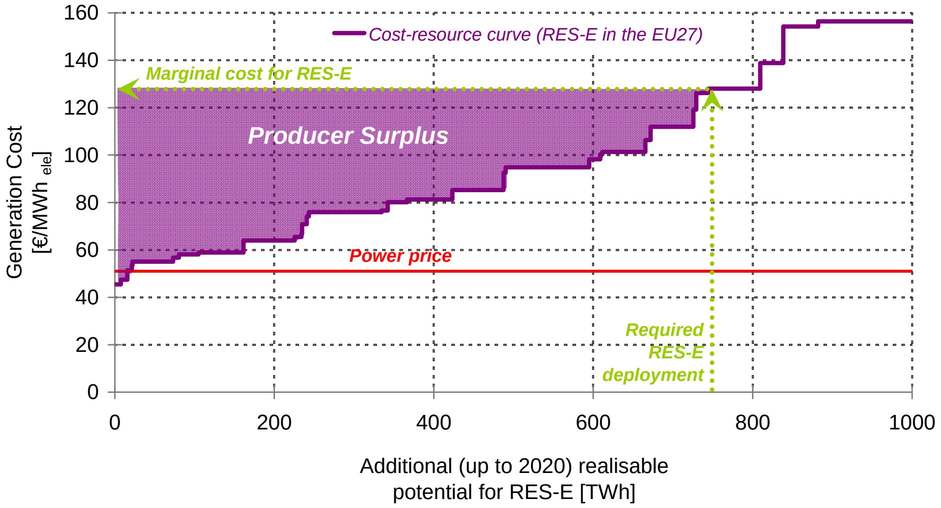

Figure 6: Producer surplus arising from technology-neutral GO trade (illustration)

A schematic depiction of the net impact on the producer rents of power producers in the European Union (EU-25) is provided in Figure 6.

Producer rents resulting from mandatory private-actor based GO trade are calculated by the Green-X model, which contains a detailed representation of costs and potentials for renewable energy sources in the EU Member States[6]. In particular two scenarios were calculated for this analysis:

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[5] 5 See page 104 in Commission Staff working document – Annex to the Impact Assessment (provisional) (European Commission, 2008).

[6] For details on the Green-X model and assumptions used in these calculations see www.green-x.at and www.optres.fhg.de. The assumptions on the future development of electricity demands and energy prices in these calculations are based on the energy efficiency scenario in Mantzos et al. (2006): “European Energy and Transport Trends to 2030” - update 2006.

Scenario I: In order to reflect the effect of mandatory private-actor based GO trade a harmonised non-technology-specific support of renewable electricity was modelled, which leads to one uniform price of GOs all over Europe (see above).

Scenario II: The second case represents a cost-reflective support for renewable electricity as currently implemented or planned in the vast majority of EU Member States.[7]. To reduce producer rents, these systems include technology-specific feed-in-tariffs with step-wise rates mimicking the cost-reductions for individual technologies over time.

The derived results comprise the transfer payments arising from the applied RE policy schemes, defined as the direct financial transfer from the consumer to the RE producer In a last step the additional producer profits occurring in the case of an unlimited private actor based trade policy have been calculated by subtracting the transfer payments occurring in both scenarios I and II. The result of this calculation is portrayed in Figure 7 as the orange line (expressed in 2005 €).

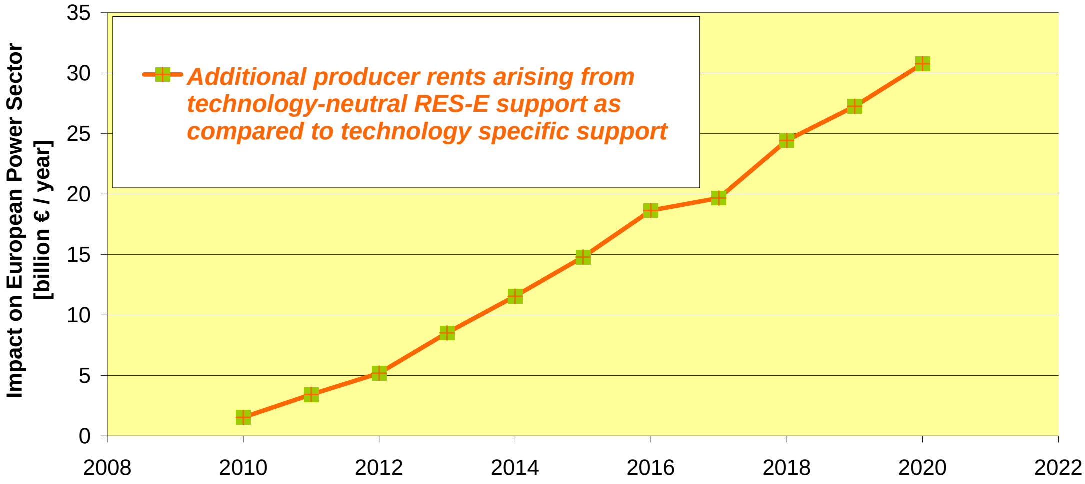

Figure 7: Impact of captured producer rents via auctioning under the EU ETS and additional producer rents arising from technology-neutral RES-E support as compared to technology specific support on the European power sector (EU25)

2.3 Different flexibility options - advantages and disadvantages

Different options to provide for flexibility for reaching the 2020 renewables targets exist. Based on the elaboration of the two previous sections the aim of reaching flexibility should be to create efficiency gains based on an optimal resource allocation but to avoid a significant increase of policy costs due to high windfall profits at the same time. Further criteria for preferable flexibility instruments between Member States are the following:

- Current national support schemes should not be negatively affected and can be tailored to meet the national RES-E policy objectives, e.g. the support of both low-cost and innovative technologies.
- The flexibility mechanism should not increase the risk for investors by creating insecurities with respect to renewables prices.
- Grid integration and secondary support costs can be reflected in the flexibility mechanism.

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[7] In particular all feed-in or premium systems offering differentiated tariffs for individual (clusters of) RES-E technologies as well as the planned banding in the UK ROCs system represent such technology-specific support schemes.

Three different flexibility mechanisms will be briefly described in the following and evaluated with respect to advantages and drawbacks:

- Transfer of renewable generation at Member State level, involving bilateral or multilateral cooperation between Member States
- A common premium or feed-in system between a group of Member States
- Trade of renewable energy certificates between private market participants.

A. Transfer of renewable generation at Member State level

From a MS perspective, the simplest mechanism to allow flexibility of RE target achievement, and at the same time maintain control of a MS's own target achievement, is the transfer on the government level, as foreseen in article 9(1) of the Directive proposal. To ensure that Member States do not sell their own renewable value while failing to deliver against their domestic target, an indicative trajectory has been defined. Member States would only be able to sell guarantees of origin (GOs) submitted for cancellation within its jurisdiction to another Member State if the selling Member State had met or exceeded the interim targets of its indicative trajectory in the immediately preceding two-year period (Article 9(1)).[8] This proposed article seems to provide a useful incentive for European co-operation. A Member State which wants to buy GOs from another Member State is likely to provide ongoing technical and other support to ensure that the selling Member State delivers its domestic objective and produces guarantees of origin which can be exported.

Under a MS trade regime, the state itself is in charge of trading. Such exchange may be based on the transfer of guarantees of origin (GO) as proposed by the European Commission or simply by exchange on the basis of the energy statistics. All renewable generation installed after the starting year of trade (e.g. 2010) are allowed for trade. The trading responsibility can be commissioned to accredited agents, e.g. the support scheme operator, the TSO, or - for GO purchase within a quota system - the quota obliged parties. The producers of RES-E do not directly sell their production to another country for target compliance. They are solely supported by the domestic support scheme.

If a MS exceeds its interim target, it can sell the surplus GOs of the interim period to other Member States. The revenues of the GO sale should be fed back into the domestic RES support (in the case of FIT systems into the FIT scheme, in the case of quota systems in other measures to promote renewables). This would alleviate the financial burden for the consumers who paid for the RES-E support. An additional incentive for target achievement could be the rule that MS that did not fulfil their interim targets are not allowed to sell GOs to other countries. If meaningful penalties are applied, this rule might not be necessary.

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[8] It might be argued that this article leaves open the question whether a MS has to exceed its trajectory only once (e.g. in 2011) and can then trade until 2020 or whether it has to be above the trajectory all the time. However, it seems likelier that it relates to *any* "immediately preceding two-year period" in which the Member State's share has been greater than or equal to its indicative trajectory. I.e., that position *vis-à-vis* the trajectory must be established for the relevant preceding two-year period every time any such transfer is attempted by the exporting MS. See, further, the Commission's explanations (Council – Note from the General Secretariat (7263/08), 11 March 2008, p. 4, para. II.3) concerning the timing in this regard (no inter-government trading until post-2013. to allow for the two-year period to be assessed).

Advantages of MS trade:

- The exporting MS maintains control of its target achievement.
- The national support schemes are not directly affected by trade and can be tailored to meet the national RES-E policy objectives, e.g. the support of both low-cost and innovative technologies.
- The MS that sells the GOs can recover costs for supporting the production of the GOs; it may also make a profit.
- No technology specific regulation is needed: the MS sells the technology mix it produced.
- Large windfall profits (as expected in a technology-neutral private GO trade scheme or in a speculative market), which lead to high costs to consumers will be avoided.
- Grid integration and secondary support costs can be reflected in the GO price.
- GOs can be traded on an annual basis as there is no linkage to support systems with their fixed support periods.
- MS trade does not increase the risk for investors by creating insecurities with respect to renewables prices.

Disadvantages of MS trade:

- The development of additional RE potentials in MS depends solely on the national support scheme in place. Consequently, in countries offering low support, RE potentials would remain untapped. Therefore it is in the responsibility of the governments to create the conditions for a surplus of renewable generation.

B. A common premium or feed-in system between a group of Member States

A possible variant of the transfer between governments is a clustering of RES support for countries using feed-in premium systems for supporting RES electricity.

The key motivation for this option is based on the fact that it allows for joint target fulfilment among participating EU countries and promises a high level of political acceptability at the same time. The potentially large acceptance of this approach follows from the fact that it allows for a clear and transparent framework based on an ex-ante definition, which regulates the sharing of additional cost for RES between potential buyer and seller countries. This fact may be different for an ex-post trading of surplus generation between countries.

In addition to the provisions provided by the Directive under article 9(1), which regulates the transfer between Member States, the possibility of a joint target fulfillment may need to be explicitly implemented in the Directive. A joint target fulfilment shall mean that a group of MSs agrees to achieve the aggregated target of the individual MSs. This may be based on a common action plan, which would be presented to the EC since the common support system would most probably be limited to electricity (and possibly large scale heating). Such action plan contains sector targets for electricity, heat and biofuels and has to be notified to the EC by 31/3/2010. This would mean that MSs present a common target for renewable electricity, if no harmonisation of policies for RES heating and biofuels is intended. Alternatively MSs may establish a multilateral agreement with no involvement of the European Commission. For proving the national target achievement GOs would be exchanged between MSs. However, according to the present Directive proposal such an exchange of GOs is only possible after the participating MSs have reached their national interim targets, which may cause a crucial barrier for the introduction of such a system.

In such a system the group of participating countries would fulfil the target of additional renewable energy (electricity) share in final energy consumption mutually. For sharing the resulting transfer cost due to RES support between the countries an agreement on a clear and transparent methodology is needed which should, in principle, reflect the share of national and international benefits caused by additional RES deployment. The different approaches and possible consequences are discussed in Resch (2008).

In general, harmonisation between participating countries should take place with respect to key parameters of the support system such as duration of support, the periods for the revision of the system and the list of technologies included in the scheme. Depending on the detailed design of the system as discussed in the following section other parameters would not necessarily be harmonised. In particular the level of the premium paid under a harmonised premium system may be fully nationally defined, partially harmonised or fully harmonised within the cluster of countries.

Advantages of a common premium or feed-in system:

- Generally all advantages of MS trade apply in this case as well.
- A common premium gives the further advantage of inherently giving the right signals for a least cost resource allocation of renewable resources among the participating countries.

Disadvantages of a common premium or feed-in system:

- It can be administratively complex to build a common premium or feed-in system between several countries as this for example requires the mutual agreements on tariffs and other key parameters by several countries (and their parliaments).

C. Trade of renewable energy certificates between private market participants

Besides the transfer at government level the Directive proposal introduces GO trade between persons in different Member States based on article (9.3). This means that a RES producer that has not already received financial support by a support scheme can sell the GOs of its RES production to any other person, e.g. a trader, a quota obliged party or an accredited agent of a Member State. The GOs counts towards the target of the Member State to whose designated body the GO is submitted (unless the MS chooses to sell the submitted GOs to another MS).

Alternative to such direct GO sales, the RES producer can choose to profit from the support scheme of another MS (article 8.1 (a) and (b)). In this case all future RES production of that RES plant has to be supported under the chosen support scheme (article 8.2). The GOs are counted towards the target of the MS that provides the financial support.

Member States may introduce a system of prior authorization to control private GO trade, if the trading scheme is likely to impair their security of supply, the environmental objectives of their support scheme or the ability to comply with their national RES targets (article 9.2).

The European Commission claims that MS will be able to block trade completely (COM 2008b), but several authors, e.g. Neuhoff et al. (2008) elaborate that, due the way the proposed Directive is formulated, such trade restrictions could only apply in exceptional cases and would not provide a means to effectively restrict or abolish trade.

Advantages of a trade of certificates between private market participants:

- A trade of certificates between private market participants ensures a least cost resource allocation of renewable resources among the participating countries.

Disadvantages of a trade of certificates between private market participants arise in particular if GO trade between private parties cannot be effectively controlled by the Member States (see Klessmann et al. (2007)):

- It leads to very high producer rents for producers of low cost technologies. If the trade between private market participants results in a uniform European certificate market total windfall profits could amount up to 30 bn. € per year in 2020.
- Member States could not prevent the export of low-cost RES-E production. Exports would be driven by RES-E producers thriving to maximize their profit. Thus all new RES-E generated in Europe would be affected by the European GO price. The export volumes would be defined by the GO price, not the government.
- Member States with feed-in systems could not prevent the import of high-cost RES-E production. If Member States with feed-in schemes would have to open their support scheme for imported RES-E, this would considerably increase the costs for consumers.
- Efficient feed-in systems would be destabilized and most likely harmonised with the European GO trading system. In particular feed-in systems would be destabilized by uncontrolled exports and imports: the overall support costs required to comply with a country's target would rise. This would endanger the political acceptance of the support system. In consequence, pressure for a "hidden" harmonisation with the European GO trading system would arise: Member States would tend to abandon their feed-in systems, or to adapt the framework conditions of the systems to GO trade
- A technology-neutral European wide GO trading scheme would increase the overall policy costs to be paid by European consumers to achieve the European 2020 targets.

2.4 Memorandums of understanding (MoUs) to facilitate transfers between governments

In order to facilitate flexibility between Member States government legal agreements or memorandums of understanding could be an important basis. The agreements would in particular define the amount of renewable electricity to be transferred, the price which should be paid by the importing country as well as the time frame for which such transfer would take place. Therefore memorandums of understanding would provide the benefit to create long term guarantees regarding prices and quantities to be transferred between countries. Furthermore such agreements could enable cooperation across different levels (national government, regulator, regions, TSO). Such memorandums of understanding would provide the conditions for a serious cooperation between governments in order to remove barriers to the large-scale use of renewables, for example in grid access design, congestion management, balancing markets, planning regimes and administrative processes.

The bilateral agreements may also include the option of project based investments similar to flexible instruments under the Kyoto protocol. Under the project-based investment mechanism, a MS that is not able or willing to fulfil its RE target solely on a domestic basis would be allowed to financially support RE plants in another country and receive GOs in exchange for target compliance (the same basic mechanism as currently discussed for harmonized GO trade between private actors). Such project-based investments could offer the possibility to access additional RE potentials in countries not interested (and not obliged) to develop these potentials themselves, e.g. - as often argued - some New Member States.

3. CONCLUSION

In this report we elaborated the prospects for renewable energy policies in Europe under the perspective of the recent Directive proposal COM (2008) 19. We reviewed the experience with existing instruments for renewable electricity in Europe by showing the impact of the different policies on the effectiveness and economic efficiency of renewables support. Thereby we showed that well-adapted feed in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity in line with the assessment done by the European Commission.

In a next step we presented the motivations to establish additional flexibility measures in the current Directive proposal. Thereby we reviewed the existing assessments on potential efficiency gains due to an optimal resource allocation of renewable energy sources in Europe. We concluded that these efficiency gains would be of the order of 2-8 bn € per year in 2020. European electricity consumers will only be able to profit from such efficiency improvement if well adapted national support schemes with technology specific support levels remain in place and if no uniform trading system for renewable energy emerges. Therefore the actual implementation of the flexibility instruments under the current Directive has a crucial influence on the fact whether or not flexibility will lead to a cost decrease for European consumers. The three most prominent flexibility instruments currently discussed have been elaborated. These are:

- Transfer of renewable generation at Member State level, involving bilateral or multilateral cooperation between Member States
- A common premium or feed-in system between a group of Member States
- Trade of renewable energy certificates between private market participants.

We found that only the first two options offer significant advantages whereas a trade of renewable energy certificates between private market participants would show large drawbacks because it leads to risk that a uniform trading system on the level of private market participants emerges. If the proposed GO trading scheme between private parties cannot be effectively restricted, the consumer expenditures for national support systems will significantly increase. This will lead to a destabilisation of national instruments and push for a harmonisation with the European GO trading scheme. An unrestricted technology-neutral GO trading scheme would increase the overall costs for European consumers to achieve the European 2020 targets by up to 30 bn € per year in 2020 as compared to technology specific support schemes.

In order to avoid such negative consequences, the relevant articles of the proposed Directive should express without any legal uncertainty that:

- Trade between Member States should become the central option for flexible target achievement.
- Trade between persons should only be introduced as voluntary alternative that can be effectively controlled by Member States.

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"RES Trading as an Option"
by Andreas Löschel

EXECUTIVE SUMMARY

The EU climate and energy package, which has been adopted by the European Commission in January 2007, comprises a 20 percent reduction of EU greenhouse gas emissions in 2020 as compared to 1990 levels as well as an increase in the share of renewable energy sources in the EU. This briefing note looks at RES trading as an option.

The economic justifications for regulatory policies in the field of renewable energy are diverse. It is crucial to be very explicit about the value attached to the different policy objectives. This is a fundamental prerequisite for each attempt to evaluate policies for the promotion of renewable energy. Cost-effectiveness should be a critical component when deciding on specific policies and measures. If the ultimate purpose of increasing the share of renewable energy sources is to reduce GHG emissions, renewable policies would be at best redundant and at worst counterproductive.

The dominant strategies for the promotion of renewables in Europe are feed-in tariff systems with differentiated (technology-specific) tariffs on the one hand and quota obligations with trade in exchangeable quotas on the other. While in principle the two systems could lead to similar results in terms of environmental effectiveness and economic efficiency, there are two major differences: the information requirement for the regulator concerning costs and potentials of different technologies and the promotion of non-competitive industries with a high future potential.While the former might lead to large inefficiencies of feed-in tariff systems, the latter cannot be achieved in a quota system but requires accompanying research and development policies.

Empirical evidence is mixed. The RES deployment in feed-in tariff systems was considerable, but came at high economic costs. The failing environmental effectiveness of quota systems was mainly due to design problems. Uncertainty concerning market developments and renewable policies was a serious obstacle to investment. Since national targets are explicitly not taking into account the resource potential of individual Member States, cost efficiency hinges crucially on a trading mechanism which equalizes shadow prices for guarantees of origin. A well-functioning green quota market achieves cost efficiency independent of underlying cost potential curves.

However, the uncertainties surrounding cost potentials have severe implications for the assessment of policies that require this information, e.g. feed-in tariff systems or Member State level trade in guarantees of origin. The proposed directive includes two approaches for trading guarantees of origin: trade in renewable generation at the government level and/or trade at the level of installations. Following the proposed directive Member States might decide to engage in trade in guarantees of origin at the government level and continue their national support schemes or engage in installation level trade in guarantees of origin with other Member States in favour of this approach.

It remains, however, unclear whether the proposed directive effectively protects domestic support schemes against private trade in guarantees of origin. Besides these legal uncertainties, the implications of the proposal in terms of cost-effectiveness are unclear.

Trade in guarantees of origin at Member State level will most probably result in an inefficient effort-sharing among Member States. The reason for this is the continuation of the feed-in tariff systems on the part of the Member States, which are problematic from a cost-effectiveness perspective, the missing penalty in the proposed directive for those Member States that do not meet their national target, and the missing market signals reflecting cost potentials, which will hardly emerge in this approach.

Efficient effort sharing in a system of GO trade at the installation level hinges mainly on credible enforcement on the part of the Member States, which is not addressed sufficiently in the proposed directive. Additional support for research and development in renewable technologies with high potential has to accompany a trading scheme at installation level.

1. INTRODUCTION

The EU climate and energy package, which has been adopted by the European Commission in January 2007, comprises a 20 percent reduction of EU greenhouse gas emissions in 2020 as compared to 1990 levels as well as an increase in the share of renewable energy sources in the EU. This briefing note looks at RES trading as an option. Chapter 2 describes economic justifications for regulatory renewable policies. Chapter 3 discusses economic concerns about the efficiency of renewable targets if the ultimate purpose of increasing the share of renewable energy sources is to reduce GHG emissions. Chapter 4 presents and assesses the current systems and experiences in renewable energy trading. Chapter 5 analyses the potentials and problems of RES trading in the context of uncertain cost potentials. Chapter 6 assesses the mechanisms currently proposed and identifies opportunities and risks regarding the proposal as well as its feasibility as an effective trading system. Finally, Chapter 7 summarizes and provides recommendations for addressing shortcomings in the proposed directive.

2. IMPORTANCE OF POLICY OBJECTIVES

The Proposal for a Directive on the promotion of the use of energy from renewable sources aims at establishing a target of a 20% share of renewable energy sources in energy consumption by 2020, which is to be binding at EU level, and establishes national overall targets for each Member State. From an economic perspective the renewable or “green” character of energy in itself is not a justification for regulatory policies. The “greenness” in itself does not directly provide a service to society.

Thus the Proposal for a Directive rather states the dual objective of increased security of energy supply and reduced greenhouse gas emissions. Besides the emission externality or the security/dependency externality, the promotion of energy from renewable sources may even ameliorate technology externalities such as market barriers to infant renewable technologies or undersupply of R&D due to knowledge spillovers and thus serve strategic interests (e.g. industry policy). All these are economic justifications for market intervention and they call for economic (price or quantity based) instruments to provide least cost solutions to reduce market failures.

While the existence of multiple policy objectives can make a case for renewable energy promotion, it also raises concerns regarding potential inefficiencies due to overlapping regulation. The cost-efficient reduction of greenhouse gas emissions can be achieved with a comprehensive market-based system of tradable greenhouse gas emission quotas.

If the policy objective were solely the "greenness" of the electricity system, a renewable exchangeable quota (EQ) system trading guarantees of origin (GO), i.e. a MWh of electricity or heat produced from renewable sources, would be an efficient way to achieve this. The quota system does not differentiate among different renewable energy sources and implicitly assigns a scarcity price to the "greenness" of electricity as a policy objective. The market identifies technologies, quantities and locations that supply green energy at lowest costs. Feed-in tariffs (FIT) on the other hand allow for a differentiated treatment of renewable energy sources in order to pursue other objectives.

If, on the other hand, the policy objective is solely to reduce greenhouse gas emissions, then complementary green energy policies run the risk of generating excess costs (see above). Similarly, if the "greenness" of the electricity system is the only objective of the renewables proposal, feed-in tariffs may come with potentially huge excess costs. These excess costs can be justified if they are paid as a premium to achieve other objectives. It is hence important to be very explicit about the value attached to the different policy objectives. This is a fundamental prerequisite for each attempt to evaluate policies for the promotion of renewable energy (Böhringer 2005). In any case, "the government should always keep cost-effectiveness as a critical component when deciding between policies and measures" (IEA 2007, page 76).

3. REGULATING GHG EMISSIONS AND RENEWABLES SIMULTANEOUSLY

The EU climate and energy package regulates both the provision of renewable energy and GHG emissions reduction at the same time. There are economic concerns about the efficiency of this approach since the ultimate purpose of increasing the share of renewable energy sources is also to reduce GHG emissions. Reflecting basic economic principles, "the use of a mix of policies" in order to pursue a single policy objective "will be at best redundant and at worst counterproductive" (Johnstone 2003): If there is one efficient instrument to achieve an environmental target, it makes little sense to introduce an additional one. Nevertheless, it is in the nature of policy design within a federal system such as the EU that instruments introduced at a European level are complemented by instruments of the Member States.

First, consider the danger of generating an excess cost burden in case of multiple regulations for one single policy goal. The danger of additional costs through inefficiencies caused by simultaneous regulation of renewables and CO_2 emissions can have two reasons. First, some activities are double-regulated – in the sense that they are confronted with costs of GHG regulations and at the same time subject to subsidies due to renewable policy – while others are not. The reasoning is as follows: If CO_2 scarcity is contained in the price for CO_2 then additional subsidies to increase the share of renewables should not be necessary and would generate an inefficiently high incentive to use renewable energies. On top of this, the overall CO_2 quantity goal (provided by the EU ETS) is covering activities that are subject to both regulations and will obviously still be reached – whether renewables are subsidised or not. The only effect of subsidising renewables inside the scheme would be to lower the price of CO_2 permits used elsewhere.

The second reason is dynamic in its nature: If renewables outside the EU ETS are subsidised, then this has to be anticipated when determining the allocation of the overall emissions budget between the sectors covered by the ETS and the sectors not covered (see above). An increased share of, for instance, wind energy achieved by subsidies will mean that fewer emissions are "necessary" for the rest of the power sector. Therefore, if one anticipates a strongly increased wind energy production due to renewable energy policy, then the allocation of the emission budget should be altered in favour of the sectors that are not subject to the emissions trading scheme.

In other words: Subsidising renewable electricity generation – which is a substitute for "average" electricity generation – induces an interaction between the two regulatory regimes (ETS and non-ETS).

From a more subtle theoretical point of view, there are several reasons why a mix of policy instruments might even be preferable to a single instrument. Differentiated instruments can be justified if there are multiple policy objectives, such as social or technology-related criteria that may conflict with pure efficiency considerations. Second-best regimes, which are characterised by initial market distortions or imperfections provide a general argument for differentiated regulation. Such regimes include situations with uncertainty, external knowledge spillovers, initial tax distortions, market power, or transaction costs. In climate policy design, sector-specific differences in transaction costs have, for instance, been used as an argument for applying different climate policy instruments to different economic sectors.

But it is again important to realize that one needs multiple policy goals in order to argue for subsidies that reach activities within the ETS. In the policy debate it is sometimes argued that subsidising renewable electricity in the ETS sectors would give an additional incentive for CO_2 emissions reduction and thus would help to reach the overall emission target. In fact, this argument can be proved to be wrong (see above). The overall level of emissions remains unchanged. In essence, unilateral renewable subsidies within the EU ETS are ecologically useless and subsidise net permit buyers while generating excess costs for the EU as a whole.

The typical justification for incentives to increase the share of renewables together with a carbon cap and trade scheme would be research, technology (or industrial) policy. If the political goal is to subsidise the development of the diffusion of a specific technology – or renewables as such – then this constitutes an additional policy goal. A similar argument holds for increasing the share of renewable energy sources in order to increase the level of energy security by reducing the dependency on fuel imports or diversifying electricity supply as such. After all, these have historically been the first reasons to provide state support for renewable energy. However, it must be clear that pursuance of these goals significantly increases the costs associated with the regulatory proposal.

4. STRATEGIES TO PROMOTE ENERGY FROM RENEWABLE SOURCES IN EUROPE

The dominant strategies for the promotion of renewables in Europe are feed-in tariff systems with differentiated (technology-specific) tariffs on the one hand and quota obligations with trade in exchangeable quotas on the other (see, e.g. Böhringer et al. 2007). Feed-in tariffs provide a high level of flexibility for policy makers. They are easily adjustable to different locations, technologies, and project sizes. They can be precisely designed to serve additional purposes such as achieving technological, industrial or regional policy goals. In fact, FIT systems stand out for large discrimination across different renewable technologies and resource availability at specific sites.

However, problems can arise if inefficient costly technologies or less attractive sites are subsidised more than renewable technologies and sites which are (almost) competitive. These inefficiencies increase the societal cost of the policy. Feed-in systems provide considerable security for investors since the tariffs are often fixed for a longer period of time. There is also the danger of over-funding. A very important – and often overlooked – fact is that actually using all these flexibilities in policy making requires the regulator to be "well informed": all technologies, their costs and, especially, the respective potentials have to be known. A quota system, on the other hand, requires very little information on the regulator side. While feed-in tariffs provide a high level of flexibility for policy makers, a quota system provides a high level of flexibility for technologies and markets.

It provides a de-centralized mechanism which leaves technology choice unregulated and ensures, in principle, cost-efficiency and effectiveness without the need for perfect information on the part of the government. Technologies are chosen because of market forces, not because of policy interventions. The quota system fosters competition among producers. It might generate high rents to producers of cheap green energy. Major disadvantages are that this provides a "tough" environment for infant technologies, or that market actors are forced to deal with risks and uncertainties concerning prices, volumes, and market development. From an economic perspective, however, non-competitiveness as a result of technical efficiency being far below theoretical potential would suggest public funding of research and development (R&D) in these technologies in order to reduce long-run costs. Subsidised market penetration would achieve cost reduction at much higher societal costs.

When comparing FIT and EQ one should consider at least three criteria: (i) environmental effectiveness in terms of newly installed renewable capacity, (ii) economic efficiency and (iii) equity or distributional effects. New installations of renewable capacity require proper economic incentives (to cover costs and risks) as well as the securing of necessary investments. The latter concerns, for instance, the credibility of policy initiatives and long-term contracts. In a FIT system the static incentive to invest is created by the difference between cost and FIT. The certainty due to fixed FIT for a very long time naturally provides for a very high (and expensive) investment incentive. Development of better technology will lower cost in the dynamic context, which would in turn lower FIT and the incentives to invest in renewables. These political risks in the FIT system are contrasted by market risks in the quota system, given uncertain RES prices. However, uncertainty in the quota system seems to stem largely from non-credible enforcement of the quota, i.e. credibility of policy initiatives.

Economic efficiency deals with the control of collective costs which depend on technology costs and the politically accessible renewable potential. Short-term efficiency considerations lead to low-cost, mature technologies. However, this might conflict with long-term efficiency, as costs might increase if research and development of technologies which are costly now – but can be expected to have a high potential in the future – has been under-funded and the technologies are not there when they are needed.

These considerations are brought forward by proponents of the FIT system. However, industrial and private consumers ultimately have to bear the short-term costs of the subsidised market penetration of non-competitive renewable technologies at early development stages such as solar cells. Employment effects are negligible and environmental benefits will not materialise. Given the co-existence of the FIT and the EU Emissions Trading Scheme (ETS), no additional emission reductions are to be expected (see previous chapter). Moreover, subsidisation in the FIT system might diminish the incentives to invest in research and development, which is necessary to achieve competitiveness in the long run. Consequently, the long-term efficiency argument would also be jeopardised. Cost implications are significant: the subsidisation regime for solar electricity in Germany, for example, might reach the level of hard coal production subsidies if extended to 2020 (Frondel et al. 2008).

Empirical evidence in comparing FIT and EQ is mixed. A considerable amount of literature examines causal links between RES diffusion and variation of design and strength of governmental policies for feed-in tariffs in Germany, Spain, and Denmark and exchangeable quotas in the UK and Italy. However, the influence of the different instruments (FIT, EQ) is difficult to isolate from other factors contributing to RES development, such as planning permission procedures, commitment, or recovery of connection costs by grid operators and benefits from other support measures, e.g. investment subsidies, tax credits, or EcoTax exemption.

Hence, it does not serve as a proof of the intrinsic performance of the instruments. On the one hand, Uyterlinde et al. (2003) claim that most of the Member States who employ feed-in tariff systems will not reach their indicative targets until 2010.

On the other hand, Germany is often used as an example of successful promotion of renewable energy. However, few studies are explicit on the high overall costs of the policy. EQ trading has not been effective from an environmental point of view in the UK. What are the reasons for this bad experience? FIT and EQ trading are, in theory, somewhat equivalent if perfect information prevails and if the quota system is credibly enforced. Both prerequisites have not been the fulfilled in recent practical examples such as the UK. Investment levels were insufficient and the quota was not reached. The high (political) uncertainty attached to RES trading requires higher rents for investment to materialize. The system was changed several times. A buy-out price prevented the quota from being achieved. Since the buy-out price was set close to the market price in the quota system, many firms decided to pay the buy-out price instead of investing in renewable capacity. What effectively happened is that the buy-out price allowed controlling the costs of the policy at the expense of the environmental target.

5. SHARING THE BURDEN: THE ROLE OF COST POTENTIALS

The 20% commitment is shared among Member States by applying a flatrate increase of 5.5% for all Member States and modulating results based on GDP per capita to reflect fairness and cohesion purposes. However, resource potentials differ significantly among Member States. Without a trading scheme, cost efficiency, i.e. a least-cost implementation of the 20% target, would require to look at – highly uncertain – cost potential curves in the Member States and assign higher targets to Member States with a higher low-cost resource potential. This policy would align shadow prices for guarantees of origin (GO), i.e. a MWh of electricity or heat produced from renewable sources.

However, since national targets are explicitly not taking into account the resource potential of individual Member States, shadow prices for guarantees of origin differ significantly. Cost efficiency then hinges crucially on a trading mechanism which equalizes these shadow prices. A well-functioning green certificate market achieves cost efficiency independent of underlying cost potential curves. Moreover, cost savings from trading guarantees of origin are higher if shadow prices differ significantly. In such a system, the allocation of national overall targets for each Member State has consequences mainly for the distribution of costs among Member States, but hardly for the total EU-wide costs of the 20% renewable target.

The uncertainty surrounding cost potentials has severe implications for the assessment of policy measures, especially when policies require information on available potentials for additional electricity production from different technologies in different regions, as with FIT or Member State level GO trade. Two definitions of potential are important: the realistic potential and the realisable potential at a certain point in time. While the realistic potential describes the maximum amount of usable electricity produced by a specific technology in a specific region after technical and non-technical constraints, the realisable potential accounts for the availability of a technology at a certain point in time. It takes into account limitations related to lead times, maximum deployment growth rates and the growth rate of the capital industry.

The Impact Assessment accompanying the Proposal for a Directive is mainly based on three economic simulation models: PRIMES, GEM-E3 and PACE. PRIMES is used primarily to assess implications of the promotion of renewables.

Comparing the PRIMES baseline with RES-E potentials from another model used for the assessment of renewables policies, GREEN-X, illustrates that already in the PRIMES baseline some technologies are used to a larger extent than GREEN-X would see as realisable potential. The excess potential reflects the amount of technology-specific RES-E potential (stemming from GreeNet) which – in 2020 – is still unused in the PRIMES baseline projections. In other words: The excess potential provides information on how much green electricity can be produced in 2020 in addition to the PRIMES baseline. The comparison does not only show substantial regional and sector-specific differences but also hints at more fundamental inconsistencies: there are evident problems for the case of wind power in Spain, biomass in Sweden and hydropower in Greece. In each of these cases the PRIMES baseline over-exploits the realisable potential provided by GreenX. These numbers suggest caution when designing policies based on numerical results of single models. Resource potentials are uncertain, especially over time, and this has to be taken into account, primarily in systems without trading. Policy design should be robust with respect to aspects where uncertainties tend to be higher. Consequently, this sheds some doubt on policy interventions in FIT in order to adjust prices.

6. TRADING PROVISIONS: GOVERNMENT LEVEL VS. FIRM -LEVEL TRADE

The proposed Directive includes two approaches for trading guarantees of origin: i) trade in renewable generation at the government level and/or ii) trade at the level of installations.

The latter allows market participants to trade GOs in other Member States independently of physical electricity trade. Member States level trade has no direct interference with national support schemes. Technology-specific rents could still be defined by Member States. With firm-level trade, on the other hand, GO trade undermines national RES support systems: investors might decide not to take advantage of the national support mechanism and sell GOs directly in another Member State if the quota price is higher than the domestic support level. Flexibility of Member States concerning the promotion of specific technologies is substantially reduced.

Using the feature of “prior authorization”, Article 9(2) allows Member States to (partly) prevent trade in GOs at the installation level and instead pursue GO trade at the government level. However, as Neuhoff et al (2008) point out, the proposal would require Member States to justify exactly why and how far the insulation of their domestic scheme is required and it remains unclear whether Article 9(2) effectively protects domestic support schemes against private trade in GOs. In any case, Article 9(1) ensures that trade at the governmental level is only possible if the selling Member State met or exceeded the interim targets of its indicative trajectory in the immediate preceding two-year period.

The proposed directive also allows for a GO trading system at the installation level among Member States in favour of this approach (Article 8(1)). To reduce the volatility of trading, trade at the installation level would be allowed only at the time of the initial investment (Article 8(2)). Following the proposed directive Member States might decide to engage in GO trade at government level and continue their national support schemes or engage in installation level GO trade with other Member States in favour of this approach. Pre-emption of Member States’ national policies is not explicitly provided for.

The creation of a new good, however, might render national support systems from legally independent national mechanisms to unsustainable obstacles to trade (reinforced by Article 9(3)). The unclear legal implications of the proposed directive and possible amendments for clarification are discussed in detail in Neuhoff et al. (2008).

Besides these legal uncertainties, the implications of the proposal in terms of cost-effectiveness are unclear. With GO trade at Member State level, an efficient effort-sharing among Member States is possible if (i) the member state regime is efficient, (ii) quotas are credibly enforced and (iii) "trade" among Member States is efficient. All of these premises are dubious: (i) The adherence of Member States to FIT is problematic from a cost-effectiveness perspective as outlined above; Member States might not efficiently implement their targets domestically. (ii) The proposed directive does not specify a penalty for those Member States that do not meet their national target; these states only have to submit an updated national action plan. (iii) Most importantly, trade among Member States is hardly a "market" that will produce the right price signals. It is completely unclear how national action plans will be aligned with GO trading. Member States with low-cost options are supposed to over-achieve their renewable targets and trade those GOs with Member States with high-cost renewable options. Member State level trade, however, might be less trading and more negotiating among few Member States. Economically reasonable price signals reflecting cost potentials (unknown to the Member States as discussed above) will hardly emerge from this process.

There is also a clear danger of market power being exploited by the few potential suppliers of GO. How will price signals at Member State level then be transferred to individual Member State schemes? How can (potential) GO suppliers implement more ambitious targets? The costs of over-achieving the targets have to be borne by energy consumers and producers, while the revenues from selling GOs accrue to the government. How can it be prevented that Member States meet empty-handed? The coordination by the European Commission will not be sufficient.

Efficient effort sharing in a system of GO trade at the installation level hinges mainly on the credible enforcement of the quota system on the part of the Member States. In this case, additional support for research and development in promising renewable technologies should accompany RES trading. In both approaches, the main advantage of cost minimisation of RES trading will materializes only if quotas are credibly enforced and failure to meet the target is sufficiently sanctioned.

7. CONCLUSIONS

This briefing note has examined RES trading as an option. The economic justifications for regulatory policies in the field of renewable energy are diverse. It is crucial to be very explicit about the value attached to the different policy objectives. This is a fundamental prerequisite for each attempt to evaluate policies for the promotion of renewable energy. Cost-effectiveness should be a critical component when deciding on policies and measures. If the ultimate purpose of increasing the share of renewable energy is to reduce GHG emissions, renewable policies would be at best redundant and at worst counterproductive. The dominant strategies for the promotion of renewables in Europe are feed-in tariff systems with differentiated (technology-specific) tariffs on the one hand and quota obligations with trade in exchangeable quotas on the other. While in principle, the two systems could lead to similar results in terms of environmental effectiveness and economic efficiency, there are two major differences: the information requirement for the regulator concerning costs and potentials of different technologies and the promotion of non-competitive industries with a high future potential. While the former might lead to large inefficiencies for feed-in tariff systems, the latter cannot be achieved in a quota system but requires accompanying research and development policies. Empirical evidence is mixed. The RES deployment in feed-in tariff systems was considerable but came at high economic costs. The failing environmental effectiveness of quota systems was mainly due to design problems.

Uncertainty concerning market developments and renewable policies was a serious obstacle to investment. Since national targets are explicitly not taking into account the resource potential of individual Member States, cost efficiency hinges crucially on a trading mechanism which equalizes shadow prices for guarantees of origin. A well-functioning green quota market achieves cost efficiency independent of underlying cost potential curves. However, the uncertainties surrounding cost potentials have severe implications for the assessment of policies that require this information, e.g. feed-in tariff systems or Member State level trade in guarantees of origin.

The proposed Directive includes two approaches for trading guarantees of origin: trade in renewable generation at the government level and/or trade at the level of installations. Following the proposed directive Member States might decide to engage in trade in guarantees of origin at government level and continue their national support schemes or engage in installation level trade in guarantees of origin with other Member States in favour of this approach. It remains, however, unclear whether the proposed directive effectively protects domestic support schemes against private trade in guarantees of origin. Besides these legal uncertainties, the implications of the proposal in terms of cost-effectiveness are unclear. Trade in guarantees of origin at Member State level will most probably result in an inefficient effort-sharing among Member States. The reason for this is the continuation of the feed-in tariff systems on the part of the Member States, which are problematic from a cost-effectiveness perspective, the missing penalty in the proposed directive for those Member States that do not meet their national target, and the missing market signals reflecting cost potentials, which will hardly emerge in this approach. Efficient effort sharing in a system of GO trade at the installation level hinges mainly on credible enforcement on the part of the Member States, which is not addressed sufficiently in the proposed directive. Additional support for research and development in renewable technologies with high potential has to accompany a trading scheme at installation level.

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"Biomass potentials and transformation strategies in the EU and policies for import"

by Francis Johnston

Summary of recent analyses relevant to the proposed Directive on the promotion of the use of energy from renewable sources COM(2008) 30

EXECUTIVE SUMMARY

Bioenergy has emerged in recent decades as an important element of the global transition towards sustainable energy. Bioenergy is available continuously, can be distributed through all energy carriers, is cost-effective across different scales, and can be applied in a wide variety of end-uses. Most global biomass consumed for energy is still used in developing countries for traditional purposes in cooking and heating. However, modern bioenergy conversion platforms are becoming more affordable and more widely available, providing new opportunities for developed and developing countries alike. Bioenergy has become strategically valuable as a way to improve energy security, promote rural development, and contribute to climate mitigation efforts. Although wastes and residues are important for environmental reasons, a major scaling up of bioenergy requires optimised energy crops.

Biomass has a prominent role to play in a sustainable energy future for the EU. Solid biomass is already widely used in countries such as Sweden and Austria for combined heat and power, district heating, industrial inputs, and residential applications. Biomass for heat and power is economically competitive under a fairly broad range of applications in most central and northern regions of the EU. Co-firing biomass in coal plants provides a cost-effective climate mitigation option, offers local resources in those cases where coal is imported, and reduces problems associated with pollutants such as sulphur. Biogas produced from animal wastes or landfills not only provides an energy-rich fuel for transport or stationary applications, but also reduces methane leakage, thereby making a considerable contribution to GHG reduction.

Use of liquid biofuels has gained more attention in recent years due to the increasing dependence on—and the increasing price of—oil imports, and the need for climate mitigation options in the transport sector. First generation biofuels include starch or sugar crops converted into ethanol through fermentation and oilseed crops which are used directly in some cases or chemically converted through esterification to biodiesel for blending with petroleum diesel. Second generation biofuels are more efficient and less land-intensive, relying on ligno-cellulosic sources and/or synthesis gas to make liquid fuels with a range of biochemical properties. Second generation biofuels remain costly and are not yet commercially available, although a number of plants are under construction and some pilot plants are operating.

The potential supply of biomass grown on agricultural lands in the EU ranges from 20% to 100% of total EU energy demand; the wide range is due to possible environmental restrictions, use of irrigation, variations in the applications and the wide range of characteristics in the types of fuels that can be used. As yields improve in new member states and as the overall efficiency of food production increases, a significant amount of agricultural land can be freed up for energy crops without impacting food and feed production. In the case of residues and woody biomass from natural forests, the potential is more modest and is highest in countries such as Sweden and Finland that have large tracts of forest.

Ukraine is the geographically closest major potential exporter of bioenergy to the EU, due to its significant agricultural land, low population density, and the fact that the population is in decline. In the case of liquid biofuels, the most likely importing regions would be Brazil and sub-Saharan Africa, due to their cost-effectiveness and large areas of available agricultural land; the lower cost and lower associated environmental impacts makes it appropriate to import some share of biofuels. Even with second generation biofuels, European producers will have difficulty competing globally in bulk volume, and are more likely to gain a competitive edge by creating markets for higher value-added products from bio-refineries.

1. BIOMASS RESOURCES AND BIOENERGY SYSTEMS

Biomass is living matter derived from plants and animals; energy sources from biomass are often divided into two main categories: wastes or residues, and energy crops. Biomass wastes or residues refer to the remaining biomass after harvesting and/or processing. The two categories differ significantly in the economics of utilisation as well as in biophysical terms.

Biomass residues include forest and agricultural residues (e.g. straw); urban organic wastes; and animal wastes. They normally offer the most widely available and least-cost biomass resource options. The principal challenge is to develop or adapt reliable and cost-effective handling methods and conversion technologies.

Dedicated energy crops refer to plantations of trees, grasses, oilseed crops and other crops that are optimised for energy production; the harvested biomass is used directly or serves as feedstock for further production of specialised fuels. The principal challenges centre on lowering biomass production costs and reducing the risks for biomass growers (e.g. stable prices) and energy producers (e.g. guaranteed biomass supply).

Like other renewable sources, bioenergy can make valuable contributions in climate mitigation and in the overall transition towards sustainable energy, but it also has two decisive advantages over other renewables. First, biomass is stored energy; like fossil fuels, it can be drawn on at any time, in sharp contrast to daily or seasonally intermittent solar, wind, wave and small hydro sources, whose contributions are all constrained by the high costs of energy storage. Second, biomass can produce all forms or carriers of energy for modern economies: electricity, gas, liquid fuels, and heat. Solar, wind, wave and hydro are limited to electricity and in some cases heat. Indeed, biomass energy systems can often produce energy in several different carriers from the same facility or implementation platform, thereby enhancing economic feasibility and reducing environmental impacts (Leach and Johnson, 1999).

Modern bioenergy systems have several other advantages over other energy resources, providing economic development benefits in addition to improving energy services. Bioenergy provides rural jobs and income to people who grow or harvest the bioenergy resources, as bioenergy is more labour-intensive than other energy resources. Bioenergy can increase profitability in the agriculture, food-processing and forestry sectors. Biomass residues and wastes—often with substantial disposal costs—can instead be converted to energy for sale or for internal use to reduce energy bills. Biomass plantations in some cases can help to restore degraded lands. Growing trees, shrubs or grasses can reverse damage to soils, with energy production and sales as a valuable bonus.

Bioenergy is inherently land-intensive (except for wastes, residues and aquatic biomass) and the associated environmental impacts (both positive and negative) are more significant, relative to the energy produced, than those of other energy systems.

A comprehensive list of environmental impacts is difficult to summarise, but some key concerns relate to loss of ecosystem habitat, deforestation, loss of biodiversity, depletion of soil nutrients, and excessive use of water. In addition to provision of a renewable energy source, some positive environmental impacts include restoration of degraded land, creation of complementary land use options, and synergies in the provision of fibre and other non-energy products. The modern concept of a biorefinery is an integrated and highly efficient agro-industrial complex that uses multiple feedstocks and creates multiple products—food, feed, fuel, fibre and more—thus maximising the value of land resources and bio-based materials.

2. LAND RESOURCES FOR BIOMASS

Use of wastes and residues for bioenergy is important for minimising environmental impacts and land use conflicts, as residues will generally require no additional land. However, use of residues is constrained by collection costs and the fact that they are not optimised for energy purposes. Scenarios for large-scale bioenergy expansion therefore assume that dedicated energy crops of some type will be grown in agricultural areas in order to maximise returns. A summary of per capita land resources for the EU and other regions is given in Table 1.

Table 1: Per capita availability and/or allocations of land (ha/person)

	Total land area	Agricultural area[2]	Permanent meadows and pastures	Arable land and Permanent crops[3]	Forests	Agricultural area and Forests
EU-27	0.853	0.392	0.141	0.251	0.317	0.709
USA	3.056	1.383	0.792	0.591	1.011	2.394
Brazil	4.528	1.411	1.054	0.356	2.557	3.968
China	0.706	0.421	0.303	0.118	0.149	0.571
India	0.262	0.159	0.009	0.150	0.060	0.219
SADC[1]	4.222	1.897	1.663	0.234	1.613	3.510

Source: calculated from FAO, 2007

[1] SADC includes the 14 countries of the Southern African Development Community

[2] Agricultural area includes permanent meadows and pastures, arable land, and permanent crops.

[3] Arable lands and permanent crops indicate current cultivation, but do not determine how much land is potentially cultivable.

In assessing availability of agricultural land for energy crops, it is generally assumed that food and feed requirements should be met first. In some cases energy crops can grow on degraded lands, thereby minimising land use conflicts. In other cases, the same crop may result in multiple products—including food, feed, fuel, fibre and other categories; such multiple-use scenarios will depend on the particular markets that develop. Provision of economic incentives for bioenergy crops should therefore be concentrated on degraded, abandoned, or marginal lands where possible, and should aim to encourage multiple products.

Woody biomass from residues and improved management in natural forests, even with fairly stringent ecological constraints, can provide a significant amount of bioenergy resources. However, use of woody biomass in some regions, is likely to be considerably constrained by factors such as the demand for industrial roundwood, use of woodfuel for cooking and the important ecological roles of natural forests (Smeets and Faiij, 2007). In the longer-term, aquatic sources of biomass could also become important, particularly algae grown for oil extraction, with the added value of avoiding land use conflicts (Briggs, 2004).

As Table 1 shows, The EU has modest land availability per capita compared to other world regions.

However, it has been estimated that self-sufficiency in food and near self-sufficiency in feed in the EU could be accomplished with a much lower amount of land per inhabitant, perhaps only 0.14-0.18 ha/person, thereby freeing up a considerable amount of land for energy crops (Ragossnig, 2007).

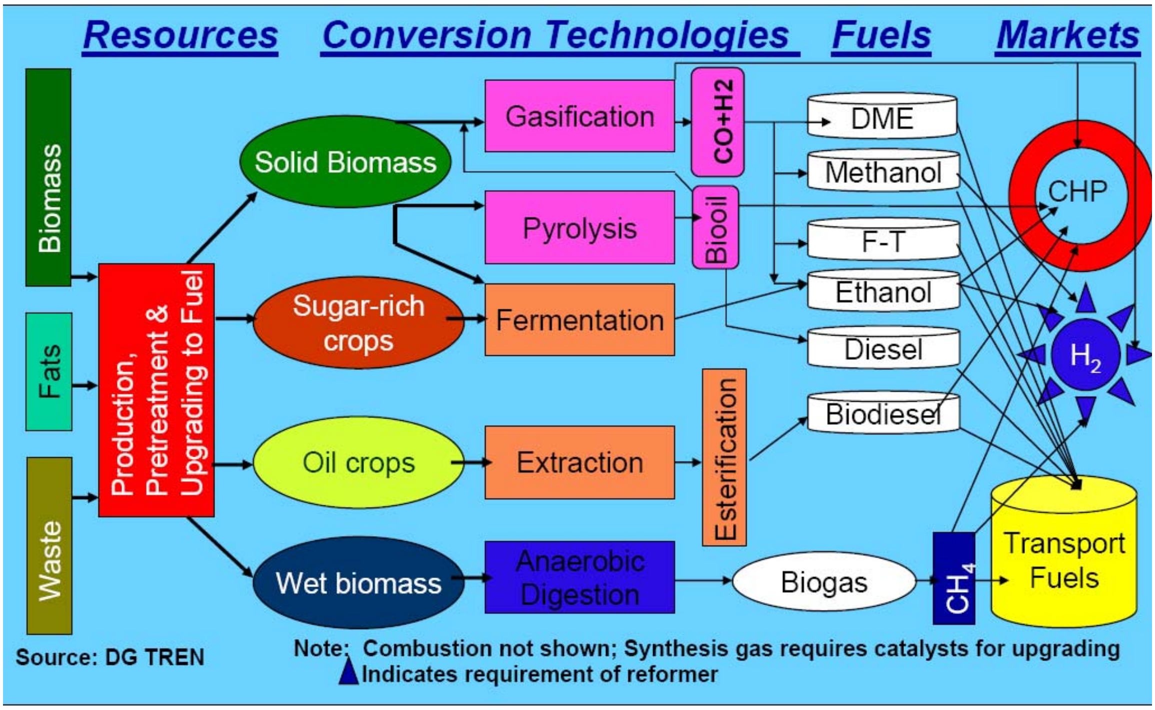
Land left fallow for ecological and economic reasons can in some cases be employed for bioenergy production; in the EU, this includes so-called "set-aside" land that has been removed from agricultural production using payment incentives.

More detailed analysis is required in order to assess bioenergy potential, since the land suitable and available for growing biomass for energy depends on many factors, including: climate and soils, availability of sufficient inputs, and various ecological factors. Bioenergy conversion options and estimated bioenergy potentials are reviewed in the next few sections.

3. BIOMASS TO ENERGY CONVERSION OPTIONS

There are many different routes for converting biomass to bioenergy, involving various biological, chemical, and thermal processes; the major routes are depicted in Figure 8. There can be intermediate steps and the various processing routes are not always mutually exclusive. Furthermore, there are often multiple energy and non-energy products or services from a particular conversion route, some of which may or may not have reached commercial levels. Figure 1 shows only the energy-related products or fuels; simple combustion is assumed and not pictured, in order to simplify the diagram. So-called second generation biofuels include those produced through Fischer-Tropsch synthesis (F-T in Figure 8) as well as ligno-cellulosic conversion to ethanol. First-generation biofuels include oil crops esterified into biodiesel and direct fermentation of sugar and starch crops.

Figure 8: Steps and resources in biomass conversion to energy products and fuels



Source: DG TREN

Note: Combustion not shown; Synthesis gas requires catalysts for upgrading
▲Indicates requirement of reformer

Source: EC DG-TREN, 2006

Due to the variety of conversion options and final products, it is more difficult to make comparisons of efficiency in biomass utilization than it is for other energy options; bioenergy extends across all energy carriers and involves many different pathways and processes.

The efficiency of biomass and bioenergy production needs to be assessed across the various parts of the chain—from the land and inputs used for cultivating biomass through intermediate processing to the useful energy that can be harnessed for particular products and applications.

On the agricultural or resource side, efficiency depends on choosing crop species and varieties well-suited to local soils and climate. In Brazil, for example, over 500 varieties of sugar cane are used for bio-ethanol production, some of which are designed and developed for optimal growth in particular micro-climates. The productivity of biomass crops grown in tropical and sub-tropical regions, in terms of energy per unit of land, is 4-6 time higher on average than typical crops grown in the temperate climates of Europe. But even within Europe, there is considerable variation in the productivity of different energy crops (discussed in section 7; see Table 7 for a summary).

In terms of minimising overall losses in the industrial conversion side of the production chain, the most efficient use of biomass for energy is for heat, including combined heat and power, where overall system efficiencies can be as high as 80-90%. Matching conversion systems to the scale and structure of demand for heat and power is necessary to minimise costs. Some conversion systems are technologically mature for use of biomass, such as steam turbines and steam engines. Other systems are still under development, such as Stirling engines and the Organic Rankine cycle. Systems differ in scale efficiencies, service requirements, and other characteristics; choice of the optimal system is thus often site-specific (Vamvuka et al, 2007).

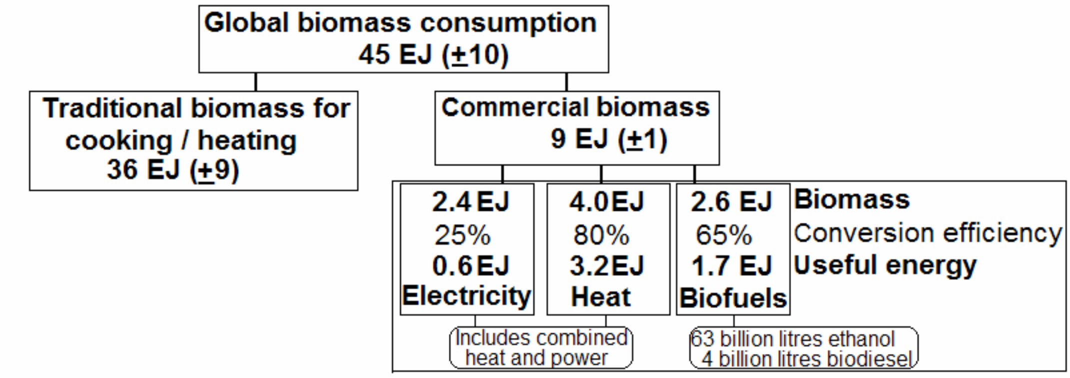
Another efficient way to use biomass is for co-firing with coal, since relatively minor modifications can facilitate its integration at a moderate cost. There are several possible technical configurations, and the need for pre-treatment and other operational measures varies with the quality of biomass (JRC, 2006). Depending on the configuration, the type of biomass, and the range of acceptable performance and reliability, the amount of biomass optimally co-fired with coal can range from 2% up to 25% (Rosillo-Calle, 2007). Co-firing with coal is the least expensive "form" of renewable energy other than large hydro, and is among the more cost-effective climate mitigation options; however, the fact that coal is still the main fuel means that it represents more of an energy/climate management device and cannot be regarded as a sustainable option in the long-term.

Liquid and gaseous biofuels are useful in extending the value of biomass to other sectors, including transport sector or in substituting for natural gas. The efficiency in conversion tends to be on the order of 55-65%. Biogas from animal wastes and other types of "wet" biomass is produced through anaerobic digestion, which is the decomposition of biomass using micro-organisms in a low-oxygen environment. Biogas can be used for many different applications: direct use for cooking or heating, electricity generation, compression for use in transport, or it can also be fed into the natural gas grid after clean-up or purification.

4. GLOBAL STATUS AND POTENTIAL OF BIOMASS RESOURCES

Biomass accounts for about 10% of the roughly 470 exajoules (EJ) primary energy that is now consumed globally; biomass accounts for more than all other renewables and nuclear power together (IEA, 2007). However, the majority of biomass use is still for traditional purposes in cooking and heating in developing countries (see Figure 9). There exists considerable uncertainty in estimates for traditional biomass use in developing countries, since these fuels are often not purchased commercially and therefore must be estimated indirectly in most cases.

Figure 9: Estimated distribution of the current global biomass supply across major energy applications



Source: IEA, 2007

A variety of modern and efficient bioenergy systems have reached maturity in recent decades and are now deployed widely, although mainly in OECD countries. As a result, there are a range of technology platforms for efficient conversion of biomass, especially in the case of heat and power. Although liquid biofuels have increased rapidly in recent years, the amount is still relatively small, representing less than 6% of the estimated supply of biomass used for energy globally.

A recent study assessed global bioenergy potential in major world regions in the long-term (2050) after accounting for food and feed production, using four scenarios under which the intensity of cultivation, level of technology, and amount of irrigation (starting from zero or rain-fed) were successively increased (Smeets et al, 2004). A summary of the estimated potentials for the four scenarios is given in Table 2.

Table 2: Estimated biomass potential for four scenarios and various world regions in 2050

	Potential (Exajoules)				*Share of world total*			
Region/Scenario:	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
North America	27	63	156	186	10%	12%	13%	14%
Oceania	40	55	92	106	15%	11%	8%	8%
East and West Europe	12	26	43	62	4%	5%	4%	5%
C.I.S. and Baltic States	48	76	188	203	18%	15%	16%	15%
sub-Saharan Africa (SSA)	46	114	280	335	17%	22%	24%	25%
Latin America & Caribbean (LAC)	58	130	202	232	21%	25%	17%	17%
Near East & North Africa	2	2	31	33	1%	0%	3%	2%
East and South Asia	37	46	181	188	14%	9%	15%	14%
World	***270***	***512***	***1173***	***1345***				
SSA+LAC	*104*	*244*	*482*	*567*	*39%*	*48%*	*41%*	*42%*

Source: Smeets et al, 2004

Overall, the global potentials range from 30% to over 200% of projected global energy consumption in 2050. Other sources of bioenergy that are not included in these potentials include animal wastes, organic wastes, and bioenergy from natural growth forests. Inclusion of such sources would increase the potentials by an additional 10 to 50%, depending on the assumptions (Smeets et al, 2007). Nor is aquatic bioenergy production included, the potential for which could be quite large, such as in the case of algae-oils for bio-diesel (Briggs, 2004).

The bioenergy potential of Latin America and sub-Saharan Africa together accounted for 39% to 48% of global potential. The high potential results from the large areas of suitable cropland, large areas of pasture land and the low productivity of existing agricultural production systems.

Since these regions together account for less than 20% of global population, they seem to be the most likely regions to become major exporters of biomass and bioenergy. Highly productive crops such as sugar cane could contribute significantly to global bioenergy supply as well as supporting sustainable development in Africa (Johnson and Matsika, 2006).

It is important to note that these are technical potentials; the economic potential would be lower, as would the potential in the case when strict ecological criteria are applied. The application of strict ecological criteria **and** economic criteria for forest-based biomass resulted in reductions of availability by more than half in many world regions (Smeets and Faiij, 2007). Such restrictions would tend to have less effect on availability of agricultural lands for bioenergy, since there is more flexibility and more options available than for forests.

5. BIOMASS POTENTIALS IN EUROPE

Biomass potential can be assessed across various end-use sectors, technology options, and product markets. Since a major scaling up of biomass-to-energy is most likely to be based on energy crops, the availability of agricultural land provides a first indication of the overall potential. A recent study evaluated the potential in Europe, focusing on the EU-27 and Ukraine. The assessment of available agricultural land, after accounting for food and feed production, in the year 2030, is summarised in Table 1.

Table 3: Estimated agricultural land available for biomass production in 2030

	SCENARIO	**EU-15+[2]**	**EU-12[3]**	**Ukraine**	**Total**
ARABLE[1] land	Baseline (trend)	19.3	23.4	22.4	65.1
	Low (more organic cultivation)	16.9	23.4	22.4	62.7
	High (higher yields)	23.4	28.3	25.4	77.1
PASTURE	Baseline	4.8	0.3	0.7	5.8
	High (as in baseline + partial use of grassland not required for feed)	10.1	8.4	5.5	24
TOTALS	Baseline	24.1	23.7	23.1	70.9
	High	33.5	36.7	30.9	101.1

Source: Fischer et al, 2007

[1] Arable land includes set-aside lands and other agricultural areas not required for food production

[2] EU-15+ includes Norway and Switzerland.

[3] EU-12 includes those countries that joined after 2004.

The land that could potentially be made available is quite significant, amounting to about 37% of total agricultural lands in the EU and 75% of total agricultural lands in Ukraine. The choice of what end-use markets (heat, power, transport, gas supply) to which the biomass supply should be directed depends on a combination of economic and political considerations.

The availability of agricultural residues from feed and food crops for bioenergy production was also assessed, and is summarised in Table 4. The energy content of residues amounts to 2.91 EJ in 2030, which is about 3.7% of projected total primary energy demand or 16.5% of transport energy demand in the EU-27 in 2030. The availability of residues decreases over time, mainly because the yields of agricultural crops are expected to increase over time, especially in the case of the EU-12 and Ukraine. With increasing yields and therefore less crop volume to provide the same amount of food or feed, the amount of extraneous residues is expected to decrease proportionally. The land freed up by increasing yields can then be used for energy crops, which results in much higher bioenergy potentials compared to residues. Especially in the case of Ukraine, the large amount of land available and the current low yields means that the potential of residues is small in relation to the potential of energy crops.

Table 4: estimated availability and energy content of agricultural residues

	Agricultural residues[1] (million tonnes dry matter)				Energy content[2] (Exajoules)			
region/year:	2000	2010	2020	2030	2000	2010	2020	2030
EU15	153	149	140	130	2.45	2.38	2.24	2.08
EU12	61	52	44	36	0.98	0.83	0.70	0.58
Ukraine	32	26	21	16	0.51	0.42	0.34	0.26
Total	246	227	205	182	3.94	3.63	3.28	2.91

Source: Fischer et al, 2007

[1] Assumes 5% removal of residues from vegetables, roots, and tubers (e.g. potatoes), and 50% for all other crops.

[2] Based on an assumed lower heating value (LHV) of 16 GJ per tonne of dry matter.

Another useful source of wastes for bioenergy production are the wastes from animal production that can be used to make biogas; manure from cattle and pigs alone has been estimated to have a potential of about 1 EJ in the EU (Nielsen et al, 2007). There are other waste streams suitable for biogas production that could double this amount; however, a really significant scaling up of biogas would require use of energy crops in order to increase the raw material supply and also to maximise yield in the anaerobic digesters. A recent study for the German government showed that it would be technically feasible to produce enough biogas to substitute for the **entire** current natural gas consumption in the EU; it would be produced from crops grown in “biogas corridors” near existing natural gas pipelines and fed into the gas grid after clean-up to reduce impurities and extraneous elements (Biopact, 2007).

The lack of progress on renewable energy in the transport sector and the lack of cost-effective alternatives to petroleum fuels have led in recent years to greater emphasis on liquid biofuels at the EU policy level. The estimated production for first and second generation biofuels using the assumptions on land from Table 3 are given in Table 5. The projected transport demand for the EU-27 in 2030 is 17.6 EJ; the potentials thus amount to about 20% to 50% of projected transport energy demand in 2030 or 40% to 70% if Ukraine is included.

Table 5: Estimated potential production of biofuels in Europe in 2030 for different scenarios (Exajoules)

		1st generation only				***2nd generation***			
		EU15+	**EU12**	**Ukraine**	**Total**	**EU15+**	**EU12**	**Ukraine**	**Total**
ARABLE land	Baseline	1.5	2.1	2.3	5.9	2.3	3.2	3.4	8.9
	Low	1.3	2.1	2.3	5.7	2.0	3.2	3.4	8.6
	High	1.8	2.5	2.6	6.9	2.8	3.8	3.8	10.4
PASTURE	Baseline	Not used				Not used			
	High	Not used				1.3	1.0	0.8	3.1
TOTAL	High	1.8	2.5	2.6	6.9	4.1	4.8	4.6	13.5

Source: Fischer et al, 2007

The use of such large quantities of land for transport fuels raises the questions of whether it would be better to prioritise biomass resources for solid fuels in stationary applications or perhaps for biogas where larger-scale use of gas is envisioned, i.e. to substitute for imported natural gas. The choice between different end-use sectors for biomass resources is to some extent a political decision in terms of supporting emerging industries and technologies. In practice, particular investments will depend on the cost and performance in particular applications and scales of demand, which are reviewed in the next section.

6. COST AND PERFORMANCE

Due to the many different options available, the costs for bioenergy systems are somewhat difficult to summarise for easy comparison; furthermore the operating costs and maintenance costs differ considerably with he type of biomass and application. The investment cost is somewhat easier to summarise in the case of stationary applications for heat (MW_{th}) and power (MW_e) as is done in Table 6. In some cases, costs are expected to come down considerably once large-scale systems are commercialised. It is important to note also that performance changes with the quality of biomass supply; for example, incineration of waste results in a lower efficiency due to the considerable variation in the combustion properties of wastes and the difficulty of controlling for such variation during operations.

For liquid biofuels, performance depends on how closely the chemical properties mimic those of the fuel they are replacing. Esterified or refined bio-diesel has properties that are fairly similar to diesel, with some exceptions, such as the tendency towards solidification of certain oils/fats produced in tropical climates when applied in northern climates. Ethanol has lower energy content than petrol, but can operate at higher compression. Other issues of concern relate to water separation; some auto manufacturers prefer strict standards on water content.

Table 6: Summary of estimated efficiencies, costs and status of current deployment for bioenergy systems

Conversion Option	Process or method	applications	capacity range	net efficiency (Lower Heating Value)	investment cost (EUR)	Status in Europe
Biogas	anaerobic digestion	Small-scale cooking or electric	up to several MW_e	10-15%	3500-5000/kW_e	well-established
	landfill gas	remediation+ energy	< 1 MW_e	15-30%	1000-1400/kW_e	attractive GHG mitigation option
Combustion	heat	domestic (modern furnace)	1-5 MW_{th}	65-90%	300-700/kW_{th}	increasing use of modern furnaces and prepared biomass (pellets)
	Combined Heat and Power (CHP)	district heating, industrial uses	1-10 MW_e	80-100% (system)	1500-2000/kW_e	widely deployed in Nordic countries, Austria, and Germany
	stand-alone	waste incineration	20-100s MW_e	20-30% (electrical)	2000-2500/kW_e	low efficiency for mass burning/incineration
		high-efficiency designs	20-100s MW_e	30-40% (electrical)	1500-2000/kW_e	well-established in Nordic countries
	co-firing	existing coal plants	5-20 MW_e	30-40% (electrical)	~250/kW_e + cost of existing plant	widely deployed
Gasification	heat	small-scale	< 1 MW_{th}	60-90% (system)	200-600/kW_{th}	commercially deployed
	CHP gas engine	small-scale	< 1 MW_e	15-30%	1000-3000/kW_e	limited deployment
	Biomass Gasification Combined-Cycle (BIG/CC)		30-100 MW_e	40-50%	5000-6000/kW_e	demonstration phase at smaller scales
			30-100 MW_e	40-50%	1000-2000/kW_e	Large-scale (long-term)
Pyrolysis	Bio-oil		< 1 MW_{th}	60-70% (heat)	??	not commercially available

Source: adapted from Faiij, 2006

The costs of liquid biofuels depend mainly on the type and costs of the agricultural feedstock supply. Production costs for bio-ethanol from first generation sources in Europe are about 0.4-0.6 €/litre, while biodiesel costs are somewhat higher. Second generation biofuel costs will initially be higher but should come down after 10 years or so. Bio-ethanol from sugar cane in Brazil and elsewhere will continue to be the most cost-effective biofuel for many years to come, due to the high productivity of the crop and the combined sugar/ethanol systems. Production costs in Brazil are already as low as 0.15-0.20 €/litre. Furthermore, second generation ethanol from ligno-cellulosic biomass could decrease cane ethanol costs further, as surplus bagasse (the fibrous residue of the cane plant) can also be used to make ethanol.

7. ENVIRONMENTAL IMPACTS AND INTERNATIONAL TRADE

It is difficult to summarise environmental impacts across all the different carriers, end-use sectors, applications, and conversion processes for biomass-energy systems. In general, most of the impacts come from the land-use side rather than the industrial side of bioenergy production, due to the land-intensive nature of biomass compared to other energy sources. Environmental impacts and emissions are closely linked to the energy and other input requirements for growing biomass; the most productive options are those that have lower input requirements and require less land and/or lower quality soils. Feedstock growing costs are also strongly related to land use, and feedstock costs are generally the major cost component for bioenergy systems.

Table 7: estimated yields, inputs, and costs for energy crops in Europe

crop	energy inputs required	typical net energy yield (GJ/ha/yr)	production cost (EUR/	status and comments
rape	11	110-180	12-20	widely grown in Germany and France, requires better quality land
sugar beet	12	250-370	8-12	annual crop, requires good quality land, surpluses used for ethanol production
SRC-willow	5	180-280	2-6	perennial crop with typical rotation of 3-4 years, suited for colder and wetter climates
poplar	4	150-250	2-4	perennial crop planted for pulpwood production, rotation of 8-10 years
miscanthus	14	180-350	2-6	perennial crop harvested each year, little commercial experience, suited to warmer climates

Source: adapted from Faiij, 2006.

A summary of the energy inputs, energy yields, and production costs for some key energy crops grown in Europe is given in Table 7. Crops used for biofuels such as rape and sugar beet require better quality land and tend to have higher inputs and higher costs. Willow and poplar are low cost and low input perennial crops that are versatile and competitive biomass resources in many regions. Miscanthus is a promising crop; it is a perennial grass in the highly productive C4 class, to which sugar cane belongs. However, there is only limited experience with miscanthus; yields and input requirements are still rather uncertain. Furthermore, its growth will generally be limited to warmer climates within Europe.

Since biomass sequesters carbon, GHG emissions of bioenergy systems are neutral. However, since there are fossil energy and other input requirements for biomass feedstocks, there are some energy losses and hence some net GHG emissions result. In some cases, there can also be N_2O and methane emissions associated with biomass for energy systems, both of which are also GHGs.

The GHG savings for liquid biofuels tend to be less than that of solid biofuels mainly because of the fossil fuel being replaced, i.e. since coal is the most carbon-laden fossil fuel, any substitution for it has proportionally higher carbon savings. For most liquid biofuels, GHG reduction is directly related to the yield and energy balance of the feedstocks. A rough indication of GHG reductions and yields for various liquid biofuels is given in Table 8.

Table 8: Estimated ranges of GHG reductions and yields for various biofuels

fuel	Process	feedstock	location	GHG reduction	yield (litres per hectare)
ethanol	fermentation	corn	U.S.	15-35%	3000-4000
ethanol	fermentation	sugar beet	Europe	45-65%	4000-5000
ethanol	fermentation	sugar cane	Brazil	80-90%	6000-7000
ethanol	enzymatic hydrolysis & fermentation	cellulosic	U.S.	70-90%	4500-5500
biodiesel	extraction & esterification	soya	Brazil	30-50%	500-600
biodiesel	extraction & esterification	rape	Germany	40-60%	1000-1400
biodiesel	extraction & esterification	Oil palm	Indonesia	75-85%	4000-6000
biodiesel	Fischer-Tropsch synthesis	various	various	50-100%	varies

Source: adapted from Sakar and Kartha, 2007

There are other potential GHG impacts associated with growing biomass, which depend on the previous use of lands. Land that stores a significant amount of carbon and is cleared to grow biomass incurs a “carbon debt” that has to be “paid off” before the system becomes a net carbon sink again (Fargione et al, 2008). On the other hand, degraded lands that are used for biofuels will tend to incur a low carbon debt or none at all, depending on the properties of soil, the root systems of the new crops, the impact on nutrients, and other factors.

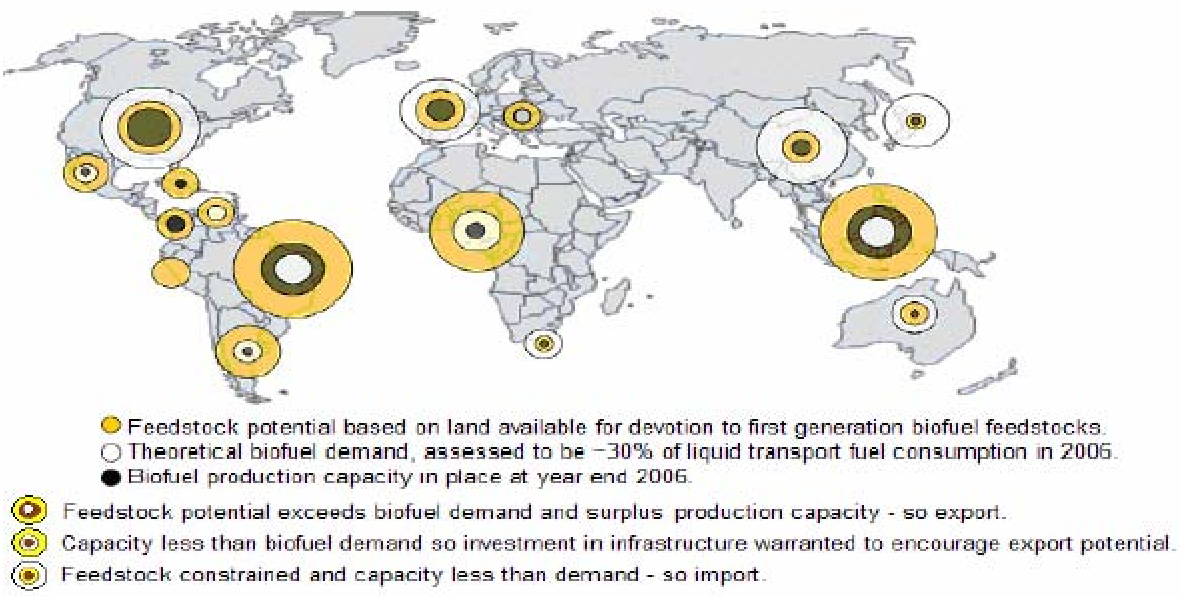
The wide range in GHG reductions and yields for biomass and biofuels, even when substituting for the same fossil fuel, are due in part to the fact that biomass that is produced in tropical and sub-tropical climates has an average productivity that is on average 5 times higher than that of biomass grown in the temperate regions of Europe and North America (Bassam 1998). Since developing countries are located predominantly in the warmer climates and lower latitudes, they have a tremendous comparative advantage. However, the large amount of financial capital available in Europe and North America facilitates the technology and strong infrastructure that can compensate somewhat for the natural disadvantage.

The underlying economic and environmental logic for North-South bioenergy trade arises mainly from this large difference in productivity. The economic and environmental costs for international transport generally amount to only 1-2% of the total product cost in the case of liquid biofuels and slightly more in the case of solid biomass trade (Hamelinck et al, 2003; Johnson and Matsika, 2006). An estimate of potential global trade in biofuels in relation to supply capacity and demand is shown in Figure 10.

The figure confirms the discussion in some of the preceding sections as to the productivity of biomass in different world regions, and combines with it analysis on the demand side in the case of liquid fuels. The high potential in the region of sub-Saharan Africa is coupled with very low demand there (except for South Africa) and consequently there is an excellent opportunity to become a major next exporter; indeed, without exports, biofuels will be less competitive due to the low demand and subsequent lower economies of scale that would result from focusing on domestic demand (Johnson and Matsika, 2006). Consequently, the notion that countries should meet domestic demand first comes in conflict in many cases with the market/trade principles of comparative advantage. Low demand and high potential is also found in Southeast Asia and parts of Latin America, which would also therefore suggest increased investment in capacity in those regions.

High-consuming regions in temperate climates such as North America and Europe will need to import under nearly any cost-competitive scenario with relatively free trade in biofuels.

Figure 10: estimated biofuel supply and demand in relation to capacity for various world regions



Source: *www.newenergyfinance.com*

8. CONCLUSIONS

Technical advances have been improving the economic attractiveness of bioenergy systems in recent decades, while at the same time social and environmental concerns are making them more politically attractive. To developed countries, modern and efficient bioenergy systems offer an opportunity to revive rural economies, improve energy security through diversification of sources and reduced reliance on imports, contribute to climate mitigation efforts, and to market advanced technologies to developing countries, enabling them to leapfrog over older technologies.

Developing countries are motivated by many of the same issues as developed economies. In addition, developing countries that are energy or oil importers can save valuable foreign exchange through bioenergy. Many developing countries also enjoy a comparative economic advantage relative to their developed country counterparts, due to lower labour costs along with the high productivity of biomass in tropical and sub-tropical climates. Bioenergy can offer opportunities for economic development in rural areas where poverty is worst and where the lagging agriculture sector would benefit from the additional investments in infrastructure.

The EU has an important role to play in the expansion of bioenergy markets both within and outside its own territory. Within the EU, the bioenergy potential is geographically found in fairly equal parts in the EU-15 and the EU-12, under the assumptions that yields in the newer member states (EU-12) will converge to those of the EU-15 over the next 10-20 years, thereby freeing up agricultural land for energy crops without jeopardising self-sufficiency in food. Neighbouring Ukraine has a bioenergy potential that is at least as large as either of the two EU regions, due to its excellent agricultural soils and its low and shrinking population density. A more modest but also fairly significant potential is found in agricultural wastes and in surplus forest residues. Taken together, this potential could be as high as the **entire** primary energy demand of the EU, although environmental restrictions and geographical constraints would probably reduce this potential in half.

The heat and power market is in some respects the best candidate for biomass applications in the EU, due to the high efficiency of combined heat and power systems, the maturity and decreasing costs of biomass applications and pre-treatment (e.g. pellets), and the possibility to substitute for fossil fuels of all types—oil, gas, and coal. The use of biogas as a substitute for natural gas and to a lesser extent for transport offers another excellent set of domestic opportunities. The technical potential for biogas in the EU has been estimated as being greater than the energy value of all natural gas currently used. Production of biogas can contribute to proper waste handling and disposal in the agricultural sector and at landfills in addition to providing an energy-rich fuel.

The technical potential for liquid biofuels for transport ranges from 20% to 50% within the EU and 50% to 75% if Ukraine is included; however, such high levels of utilisation would impact availability of biomass for other uses. Given that liquid biofuels generally require more land and resources than other bioenergy applications per unit of energy delivered, it is probably not economically or environmentally attractive to divert such large amounts of biomass to liquid biofuels in regions that are densely populated such as Western Europe.

Even with second generation biofuels, it will be difficult for European producers to produce the large bulk volumes required at competitive prices; furthermore, the high productivity of biofuels produced in tropical regions means that imported biofuels will be cheaper and can potentially have much lower environmental impacts. The economic and environmental logic thereby emerges for importing some share of liquid biofuels from highly productive regions such as Brazil and southern Africa, while devoting a relatively larger share of biomass resources from within the EU for solid biofuels and for biogas. European producers would still produce some biofuels, but could concentrate more on multiple products through biorefineries, so as to take advantage of their technical comparative advantage in markets for higher-vale added products such as bio-chemicals.

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"Sustainable Biofuels Criteria
Managing risks into opportunities"
by Charlotte Opal

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EXECUTIVE SUMMARY

Global stakeholders expect that biofuels contribute to climate change mitigation whilst being socially and economically sustainable. Sustainability standards for biofuels production and processing will be required to ensure this. The Roundtable on Sustainable Biofuels is hosting an international multi-stakeholder dialogue to draft globally-accepted standards for sustainable biofuels to ensure that they deliver on their promise of sustainability.

Social criteria and measuring and mitigating indirect effects are essential components of the Roundtable's principles and criteria. Scientists, economists, and conservation specialists must work together to determine the indirect impacts attributable to biofuels.

Special tools will be needed for small farmers to ensure that they can gain access to sustainable biofuels markets and to drive investment to those chains that offer the highest levels of social and environmental sustainability, as currently this type of production is not rewarded in the market.

1. INTRODUCTION

While biofuel development can enhance rural livelihoods, contribute to climate change stabilization, and diversify energy sources, it can also increase pressure to convert biodiverse areas to cropland, displace indigenous people, and even worsen greenhouse gas balances. Environmental and social safeguards are thus necessary to ensure that biofuels indeed deliver on their promise of sustainability.

In April 2007, the Energy Center at the Swiss Federal Technical Institute in Lausanne (EPFL) launched a multi-stakeholder effort, the **Roundtable on Sustainable Biofuels (RSB),** to develop international standards for sustainable biofuels production and processing. By mid-June 2008, the RSB aims to have draft standards developed in conjunction with non-governmental organizations, companies, governments and inter-governmental groups from all over the world.

The RSB is led by a founding multi-stakeholder **Steering Board** in which participate individuals from WWF, the UN Environment Programme, Toyota, Shell, BP, the University of California at Berkeley, the University of Keio in Japan, TERI India, Bunge, the Swiss and Dutch governments, Petrobras, the Mali Folkecenter, the World Economic Forum, UNCTAD, and others.

Over 200 individuals from nearly forty countries are participating in Working Groups to draft the standards via consensus-based teleconferences and online discussions. In addition, three regional workshops have been held in Brazil (October 2007), Shanghai (November 2007), and South Africa (March 2008), with further discussions planned for India, Colombia, and West Africa later in 2008.

As in other sustainability initiatives, the RSB is developing **principles, criteria and indicators** to define sustainable biofuels production and processing. These standards will be applicable to any first or second generation biofuel, from any feedstock or geographical origin. Similar to the approach taken by the UK, Dutch, and German governments, the aim is to develop a generic meta-standard against which crop and country-specific standards can be benchmarked and recognized, to reduce reporting and verification burdens for farmers and companies.

This document will focus on the questions put forth to the author before, during, and after her presentation to select members of European Parliament on March 13th. More information about the Roundtable can be found on the RSB website, http://EnergyCenter.epfl.ch/biofuels and on www.BioenergyWiki.net. This document should not be considered the views of the Roundtable's Steering Board or any of its members, but rather of the author, based on discussions being held in the Roundtable with hundreds of actors involved in biofuels.

2. KEY SOCIAL PRINCIPLES

The eleven principles proposed by the Steering Board are in their third version, downloadable on the RSB website. These principles were drafted using the Dutch, UK, German, WWF, Brazilian, Californian, crop-specific, and other sustainability criteria as a starting point. They have been discussed and reviewed by hundreds of people in several countries. While different regions and crops present different concerns (land rights are generally not violated in most European countries, for instance), there is broad consensus that all eleven principles must be followed to ensure that biofuels are produced in an economically, socially, and environmentally sustainable way.

Of these eleven principles, four relate to specific social impacts of biofuels production and processing. The four social principles and a summary of draft and likely criteria are presented below.

Principle 2:

> *Biofuel projects shall be designed and operated under appropriate, transparent, consultative, and participatory processes that involve all relevant stakeholders.*
>
> This principle is especially relevant for new plantations or facilities. Many stakeholders in developing countries have indicated that new biofuels projects, some of which are intended to produce for the European market, are being planted in areas without clear land rights and where indigenous groups and/or local communities have been using land and are now unable to access it. Community consultation ensures that the production will not be protested by the community, and is a contributor to economic sustainability of the biofuels project.
>
> Criteria for this principle include the participation of local communities in every step of the process (impact assessments, production planning, operations, etc.) The notion of Free Prior Informed Consent remains central, especially for production sites located on lands owed by indigenous people and where customary rights prevail.

Principle 4:

> *Biofuel production shall not violate* ***human rights or labor rights****, and shall ensure* ***decent work and the well-being of workers.***
>
> Agricultural production in some countries does not follow basic UN Human Rights or core ILO labor standards. Criteria for this principle will prevent labour and human rights violations and require ILO conventions regarding occupational health and safety to be followed. A separate principle on national law will also require minimum wages to be paid.

Principle 5:

> *Biofuel production shall not violate* ***land or water rights****, and shall contribute to the* ***social and economic development of local, rural, and indigenous peoples and communities****.*
>
> As stated above, new agricultural projects can encroach on community or indigenous peoples' land in countries without strict legal frameworks for recognizing land rights. Some stakeholders have also complained that biofuels projects are taking water upstream and reducing water availability to downstream communities.
>
> Ensuring that rural, local, and indigenous communities benefit from biofuels projects will also reduce the likelihood of local food security impacts.

Principle 6:

> *Biofuel production shall not impair* ***food security****.*
>
> As one of the most controversial impacts of biofuels, the question of competition with food production is a central social principle in sustainable biofuel production. Because the world's rural poor spend on average 50-80% of their income on food, food price increases are a major concern. The majority of the rural poor are net food buyers, and are thus nearly as vulnerable as the urban poor to food price increases.
>
> Finally, while many stakeholders hope that biofuels production will bring jobs and income to rural areas, if food prices rise then these potential benefits are lessened as real incomes will remain constant or even decrease.
>
> The impacts of biofuels production on food security are both local (remote communities that choose to replace food crops with fuel crops are increasingly vulnerable to local food price shocks) and global (major diversions of food crops for use as fuel will reduce the amount of food available and drive up global prices). The likely criteria for this principle will both encourage practices that promote local food security (food and fuel intercropping, higher real prices for farmers and wages for workers) and devise tools to mitigate the global indirect impacts. Indirect impacts will be discussed further below.

Other principles touch on social concerns; for instance the principle on conservation requires protection of High Conservation Value Areas, which include land with cultural or economic value. The criteria for the principle on technology require that each stakeholder is provided full and transparent information about the use of particular technologies, to prevent producers from using, for instance, biotechnology without their knowledge, and does not allow producers to be forced into using a particular technology.

3. INDIRECT EFFECTS

The eleven principles being discussed in the RSB are summarized in the categories presented in the table below. Compliance with each of them is directly affected by on-farm and in-factory practices, while in addition three of them (greenhouse gas balances, loss of conservation areas and biodiversity, and rising food prices leading to food insecurity) can also fail to be met because of the *indirect* effects of biofuels production displacing or crowding of current uses of land.

Principle	Directly impacted	Indirectly impacted
National Law (esp. re. land, labor, water rights)	✓	
Community Consultation (esp. to determine land rights, social & environmental impact, idle land, resolve grievances)	✓	
Social – biofuels should benefit rural communities and workers	✓	
- should not contribute to food insecurity	✓	✓
GHG (positive balance over lifecycle)	✓	✓
Environmental – conserve and protect soil, water, air	✓	
- conserve and protect high conservation values	✓	✓
Technology – potentially hazardous technologies (for instance GMOs) should be used responsibly and transparently	✓	

Recent studies have shown that the indirect effects of some biofuels' production could lead to even worse impacts on environment and people than the fossil fuel benchmark. As for many stakeholders the main attraction of biofuels is their promise of sustainability, biofuels supporters will expect that these potential negative effects are outweighed by the positive benefits, and/or mitigated or compensated.

There are three sources for biofuels that do not compete with land for food, feed, fiber, or wilderness and thus would have no indirect effects:

- *Biofuels made from waste or residues.* Because waste and resides are defined by the UNFCCC as having 'no or negligible value', they cannot be a market driver for land use changes; nor can they replace food or feed production.
- *Biofuels made from new biomass resulting from improving yields on a currently-used piece of land.* Significant gains in productivity can be made on land currently used today, especially in Africa. Better seeds, farming techniques, and capital investments such as drip irrigation can all increase productivity without requiring new land use changes or reducing food production. Winter cover crops can be added in regions where they are not used currently, which would also be considered 'new' biomass not competing with other uses for the land, and has the added benefit of preventing erosion and sequestering soil carbon.

- *Biofuels made from new biomass grown on marginal or degraded land*. One billion hectares (about 8% of the world's total land area) is considered unsuitable for food production, because of rising salinity levels, desertification and erosion, and other human-induced impacts. These could be reclaimed for productive use by growing fuel crops that would not compete with food production or displace other production and result in negative land use changes.

Any biofuel that meets one of those criteria could be considered as having *no* indirect effects on greenhouse gas emissions, food security, or biodiversity. As long as the fuel meets the other minimum criteria regarding direct social and environmental impacts, global stakeholders would then likely consider the biofuel sustainable.

Any biofuel that does **not** meet one of these criteria will likely have *some* indirect impacts, although they will vary from product to product. Measuring these indirect impacts is extremely difficult, because:

- many farm products are substitutes for each other (soy and palm oil are used interchangeably in some processed foods, for instance) and thus their prices are driven by changes in many different markets;
- agricultural products are traded globally and thus a diversion of food to the fuel market in one country might lead to a land use change on the other side of the planet; and
- causality of land use change is difficult to measure because it requires aggregating farmer behaviour in response to many different signals.

However, we can safely say that for crops that do not meet any of the exemption criteria outlined above, some negative indirect impacts on land use will occur. Just because it is difficult to measure does not mean that we can ignore what threaten to be significant impacts.

Measuring how much food or wilderness that a particular biofuel is displacing is a relatively new topic for scientists, and there is not yet consensus on how to do it. To estimate how much land use change or price increase a particular biofuel might be causing requires a detailed understanding of the drivers of land use change – the economic decision-making that landowners take when deciding how to use their land.

Forests might be first cleared of their valuable timber, then wood taken out for pulp and paper, then the remaining brush burned to farm cattle for a few years, and then finally soy production might start. This soy is used mostly as animal feed, with the soy oil used in biodiesel usually a co-product with less value. How much of that initial deforestation, then, shall we contribute to soy biodiesel?

Food prices are also difficult to link to increase in demand for a particular biofuel, as the price elasticities (by how much percentage demand will go down with each one percent increase in price) vary for different crops. But it seems clear that increasing protein consumption, weather shocks, higher costs of production due to increasing fuel prices, and commodity speculation seem to be bigger drivers of food price increases than biofuels demand per se. According to André Faaij at Utrecht University, crops currently used specifically for biofuels use only 0.025 billion hectares of arable land, compared with 1.5 billion hectares used for food, feed, and fiber, and 3.5 billion hectares used for pasture.

Given the newness of the topic, there is as yet no consensus on the exact extent to which biofuels are causing price increases or indirect land use change. The level of uncertainty is such that some scientists prefer to not even try to calculate negative indirect effects of biofuels production. However, we have indicated above that there is *some* negative indirect effect of biofuels production, unless some very specific conditions are met.

Scientists modeling land use change, economists modeling price changes, and conservationists who understand the drivers of deforestation and other land use change must work together to come up with estimates of the indirect effects, at which point mitigation measures (reducing the GHG benefit of the biofuel by the appropriate amount of carbon lost through land use change, purchasing a biodiversity offset, supporting a food security program, etc.) can be discussed.

4. POSITIVE VS. NEGATIVE CRITERIA

The criteria being developed in the RSB are considered as minimum acceptable criteria for ensuring biofuels' sustainability. In addition, better practices for each principle are also being defined where applicable. The various unacceptable, acceptable, and better practices can be mapped out into a scorecard, presented in the Appendix.

It should be noted that on some farms there are quick wins to be made where yields can be increased without increasing environmental impacts through smarter use of inputs, or yields maintained by using fewer inputs more efficiently, and that investment in low-productivity farms and underutilized land can pay itself back rather quickly. But at some point protecting biodiversity, paying better wages, and having a significant rural development impact will cost more than farms with adequate but not optimal social or environmental performance. Eventually, one could direct subsidies, quotas, or development financing to the truly 'green' fuels, or make a market for better practices by requiring companies to buy a certain amount of fuels that meet the higher-bar standards.

5. STANDARD SETTING AND MARKET ACCESS

For sustainability criteria to be widely adopted and implemented, it is essential that the private sector, producers, and civil society are involved in their development and support the results, otherwise mainstream adoption cannot occur and unsustainable biofuels will continue to be traded. Any sustainability criteria development must thus be undertaken in an open and transparent manner, involving large actors but also small farmers, indigenous people, and other normally marginalized stakeholders to ensure that their concerns are reflected.

The International Social and Environmental Labelling Alliance (ISEAL, www.isealalliance.org), a coalition of sustainability standard-setters, has created a Code of Good Practice for Standard-Setting that meets WTO requirements for ensuring that standards do not represent technical barriers to trade and outlines the participatory process needed to ensure that all affected parties have a voice in how standards are set and monitored. Any biomass sustainability standards should follow the ISEAL code as they are being written. The Roundtable on Sustainable Biofuels is using the ISEAL code and is applying to become an Associate Member of ISEAL.

Once global sustainability standards have been agreed, it is likely that voluntary or even mandatory certification systems will be developed to verify compliance with the standards, to facilitate international trade and back up company sustainability claims. Special care must be taken to ensure that smallholder farmers and small businesses in developing countries are not excluded from certification systems.

These groups are often not able to certify their products both because the cost of proving compliance with standards (e.g. maintaining written records and creating internal control systems to monitor small farmers) can be expensive for small actors, and because the costs of third-party certification are higher for small and dispersed groups than for large parties.

As providing market opportunities for small farmers to sell biomass and bioenergy can be an important driver for rural development, special efforts must be made to ensure that these groups are able to access any sustainability certification schemes. Possible mechanisms could include scholarship schemes to help pay for certification, capacity building to help cooperatives comply with standards, or consumer labels like Fair Trade that prioritize small farmers and best-practice working conditions. Multi-lateral lenders and governments should prioritize bioenergy that comes from such chains that really do provide rural economic development but which might not always be rewarded in a marketplace which does not recognize these types of positive externalities.

6. CONCLUSIONS

With sustainability standards preventing unsustainable biofuels from reaching the market and new tools to prioritize best performers, a sustainable biofuels industry can be created that will contribute to climate change mitigation, a diversification of energy sources, and rural regeneration. Consensus among scientists, economists, and conservationists is urgently needed to measure and mitigate unintended negative consequences that are not easily addressed through farm and factory standards. The Roundtable on Sustainable Biofuels is working to address all of these needs through an open, consultative stakeholder discussion and feedback process.

Any sustainability standard must be developed through an open, transparent stakeholder process, ideally compliant with the ISEAL code, which is also in line with WTO norms for standard-setting. Special care must be taken to ensure that small farmers and small business, especially in developing countries, are not excluded from access to sustainable markets because of their higher costs and barriers to paying for and complying with standards and certification.

Annex

Roundtable on Sustainable Biofuels - Draft Scorecard Concept							
	Overall Energy and Greenhouse Gas Efficiency	Conservation of Natural Resources				Social Concerns	
	Total score for product life-cycle (well-to-wheel)	Biodiversity	Soil health	Air quality	Water use	Food security	Rural/Social Development
Considerable reduction of ecolog./ social footprint	Low GHG emissions, maximize carbon sequestration (e.g. low-till)	Biodiversity corridors, using degraded land	Restore degraded land	No sig. impact on air quality on farm or at processing facility	Use of non-thristy crops	Use of degraded or idle land	Best-practice wages and working conditions, Fair Trade
Small or no reduction on ecolog./ social footprint	10-90% GHG emissions as compared to fossil fuel	Buffer zones	Erosion protection	Moderate impact on air quality	Moderate impact on local water quality, quality		
🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
No or negative impact on ecolog./ social footprint	High N2O emissions from fertilizers, conversion of high carbon-stock land	Deforestation, habitat encroachment			Water pollution, significant reduction in water availability		Hazardous or illegal working conditions