The Implications of Tradable Green Certificates for the UK

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Executive Summary

A Green Certificate (GC) is used to represent the 'greenness' of a unit of renewable electricity. This allows the unit to be divided into two parts: the physical electricity and its associated greenness. If the two parts are regarded as distinct, they can then be traded in two separate markets: the conventional physical electricity market and the market for greenness. Within a situation where there is an imposed demand (ie an obligation) GCs serve two purposes:

- they act as an accounting system to verify whether the obligation has been met
- they facilitate trade which allows the obligation to be filled either by buying physical electricity with GCs or by GCs alone in the alternative tradable green certificate market (at which point they become TGCs)

The UK could establish a national TGC market where only UK-generated TGCs were valid or the UK could become part of a wider trans-national market (for example, made up of EU countries) where TGCs from all EU countries are valid.
A national TGC system would be easier to establish than a trans-national system. This is because a TGC has to be both accredited and standardised so that TGCs are a defined product.

Within a UK national system, there is the prospect of four uses for GCs:

- combined GCs & kWh used to qualify for the Climate Change Levy (CCL) exemption for large business users, but not eligible against the RE obligation (not agreed as yet by Customs and Excise or DETR);
- combined GCs & kWh used to obtain the CCL rebate for small business users, (also eligible against the RE obligation);
- GCs traded separately or combined with kWh which can be used against the RE obligation;
- GCs traded separately or combined with kWh which are used within voluntary green power supply, which cannot be used against the RE obligation.

With trans-national trade there are a number of key issues which have to be decided upon:

- what is traded when a GC is bought?
- which country receives the credit - both for reduced emissions and renewable energy deployment - the country of redemption or the country of generation?

Assuming that both emissions reduction and renewable deployment credit rests with the country of redemption, there are a number of implications for the UK remaining a national system, separate from trans-national trade:

- it ensures that all benefits and costs of the UK's renewable obligation and TGC system can be said to be feeding back directly to the UK;
- it allows a wider selection of technologies to be brought forward by the obligation;
- it is easier to establish and administer.

While more complex to establish, the implications of trans-national trade are :

- UK suppliers would have access to a wider pool of renewable generation which would allow lowest cost fulfilment of obligation;
- if the UK resource (and TGCs) are cheaper in the short term (as expected) renewable companies should capture a bigger market (and accrue benefits of increased jobs and local pollution benefits);
- if the UK TGCs are more expensive, then the UK can buy in CO_2 credit more cheaply than from UK sources but at the expense of losing the benefits of developing the UK RE industry.

Contents

1. Introduction

The UK has an ambitious target of working towards 10% of its electricity production from renewable sources, if possible by 2010[1].

The mechanism set out in the recent Response to the RE consultation is to use a system of Tradable Green Certificates (TGCs). This report explains the theory behind TGCs, how they could be used in practice and the implications for the UK. There are a number of key decisions which have to be taken before a TGC system can operate efficiently and effectively.

This report has the following structure :

Chapter 1.	This Introduction
Chapter 2.	What is a Tradable Green Certificate ?
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Chapter 4.	The Implications of a Tradable Green Certificate System for the UK
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This report builds on work carried out by the authors and many other people elsewhere. Foremost among these is the EC-funded research project 'The Implications of Tradable Green Certificates for the Deployment of Renewable Energy' (Altener XVII/4.1030/Z/98-037) which was completed in December 1999, and we gratefully acknowledge the work of our colleagues in that study. We recommend the final report of that project (see Schaeffer et al, Jan 2000) as further reading. A list of additional references is also given at the end of this document.

[1] DTI, 2000, New and Renewable Energy – prospects for the 21st Century, Conclusion in Response to the Public Consultation, 1 Feb.

2. What is a Tradable Green Certificate ?

A Green Certificate is used to represent the 'greenness' of a unit of renewable electricity generation. This allows a unit of renewable electricity generation to be divided into two parts - the physical electricity and its associated 'greenness'. If the two parts are regarded as being distinct, they can then be traded in two distinct markets: the conventional physical electricity market and a market for the 'greenness'.

Within a situation where there is an imposed demand for renewable electricity (i.e. an obligation) GCs serve two purposes:

1. They act as an accounting system to verify whether the obligation has been met;
2. They facilitate trade through the establishment of a separate market for the 'greenness' so that an obligation may be fulfilled by buying TGCs either together with physical electricity or separately.

On hearing of the concept of TGCs, a number of questions are immediately raised which include :

- Why have Tradable Green Certificates in the first place?
- How are they created in practice?
- How might a market for Green Certificates operate ?
- What are you buying when you buy a Tradable Green Certificate, i.e. what is the greenness?
- How might Tradable Green Certificate systems interact with other ways of supporting RE?
- How might they interact with efforts on Climate Change ?

We go through the main questions below.

2.1. Why have Tradable Green Certificates?

The concept of TGCs has developed because there is a need for a support mechanism to achieve ambitious targets for the deployment of renewable energy within liberalising electricity markets. In the UK, as in many countries, this is given impetus by legally binding commitments to greenhouse gas reduction. In the EU this is also governed by the timetable of the Directive for a Single Electricity Market.

Analysis of the experience of renewable energy deployment in Europe shows that competitive mechanisms, such as the UK's Non-Fossil Fuel Obligation, have been very successful in reducing the price paid for renewable generation but less successful in deploying capacity.
On the other hand, fixed payment mechanisms (such as the Feed-In Tariff in Germany) have been successful in increasing RE deployment but less successful in reducing the price of renewable generation.

Tradable Green Certificates, in theory, combine the means of supporting renewable energy at least (or low) cost while at the same time enforcing deployment.

- This should promote competition between generators which should in turn lead to declining costs of RE generation.
- The ratchetting up of the obligation over time (for example 5% of electricity supply in 2003 up to 10% of supply in 2010) will increase demand for TGCs, so attracting new developers into the market.

In this respect, the TGC system is considered a cost effective way to meet ambitious renewable energy targets efficiently.

2.2. How are Green Certificates Created ?

A Green Certificate is a 'document'[2] that proves that a unit of electricity has been produced from an RE source. Generators receive a certificate for each pre-defined unit of electricity produced from their RE scheme that is delivered to the electricity network. Electricity from RE schemes is indistinguishable from other electricity, so the certificate is used to represent the 'renewableness' or the 'greenness' of the electricity. A GC becomes a Tradable Green Certificate (TGC) when the mechanism allows trading of GCs as a means of meeting an obligation.

2.3. The Green Certificate market

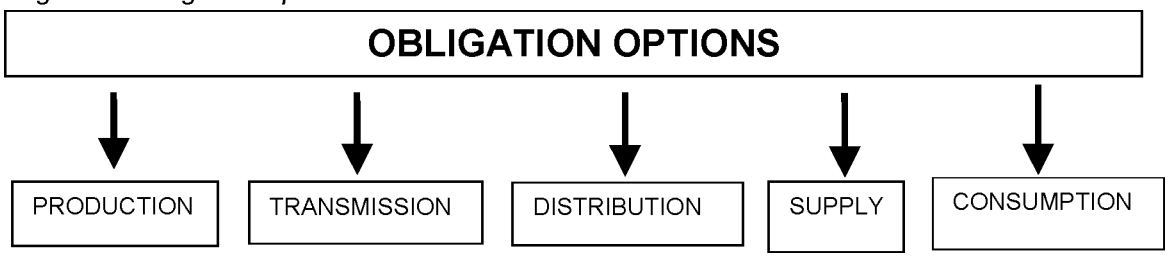
In order to create a strong demand for electricity from RE sources, an obligation for a quota of RE- electricity has to be placed at some point in the electricity supply chain.
Penalties are incurred if the quota is not met.

2.3.1. The RE Obligation

The obligation can be placed at any point on the electricity supply chain.
The obvious points are :

1. Production
2. Transmission
3. Distribution
4. Supply
5. Consumption

Figure 1 : Obligation Options



[2] For practical purposes, Green Certificates are more likely to be electronic documents than paper documents.

In the UK it has been proposed that the obligation be placed on suppliers[3]. In order to show that suppliers have fulfilled their obligation, they have to provide the amount of GCs equal to their obligation at an agreed point in time to an agreed accredited body. A supplier may not wish to contract directly with a green generator to buy physical electricity but to buy GCs and use them to prove that they have fulfilled their obligation.

2.3.2. The 'Tradable' Obligation

Suppliers will have to purchase TGCs either from a generator or from another body which has already bought TGCs. At its most simple, the price of a green certificate will be the difference between the market price for electricity and the premium price (if any) for the renewable electricity. This means that generators of the cheapest renewable electricity will be able to sell TGCs at the cheapest price and therefore they should sell their TGCs without difficulty. However, the price will also depend on the market, in other words on the demand and supply of TGCs. With a low supply of TGCs, the price will be high, providing an incentive for new generators to enter the market to provide more renewable electricity. Moreover, in theory, renewable energy will be provided in an efficient way because those generators who can provide renewable electricity at the lowest price should find it easiest to sell their TGCs.

2.3.3. TGC Market Theory

In theory the ideal TGC market can be described by the relation between supply and demand (or price). The extent to which this will occur is of course debatable but it is useful, in the first instance, to be introduced to its basic concepts. Actors will pay a price for TGCs in order to meet their obligation. The price they pay will depend on the market, i.e. on demand (which is fixed by the target) and supply. With a low supply of TGCs, prices will be high, providing an incentive for new producers to provide renewable electricity. In theory, electricity from renewable energy will be provided in an efficient way and prices will be driven down by competition between producers. Box 1 (over) shows the economic theory.

[3] Other countries are considering other options. In Denmark, for example, the obligation is to be placed on consumers, in line with the 'polluter pays' principle.

Box 1 : The Market Price for Green Certificates

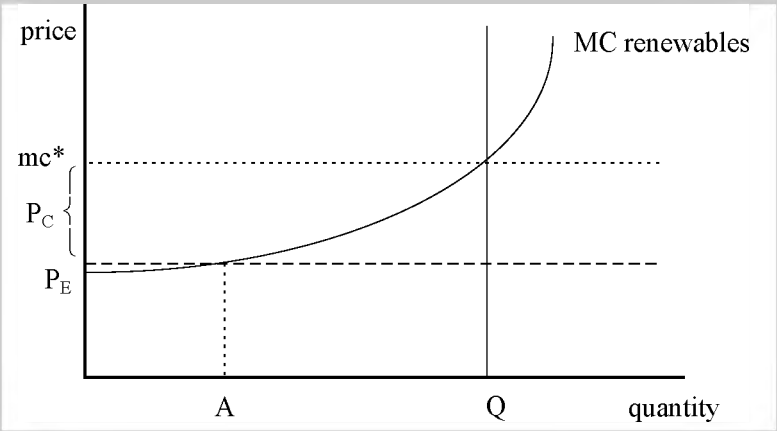


Figure 2 : Market for Green Certificates

MC renewables is the marginal production cost curve of electricity from renewable energy sources.

The target is set at Q, with corresponding marginal cost mc*.

Given a market price for electricity of P_E, the certificates will be sold for P_C = mc* - P_E.

Given the market price for electricity as drawn here, P_E, part of the renewable energy (up to A) would be produced even without a green certificate system, because it is already profitable. For these producers (if they are allowed to trade in the system), the green certificate system will create extra profit (the difference between mc* and P_E).

The total profit due to the obligation for renewable producers from the sale of electricity and the green certificates is equal to the area between the mc* line and the marginal cost curve, MC renewables.

Source : Schaeffer, G.J., M.G. Boots, T. Anderson, C. Mitchell, C. Timpe, M. Cames (January 2000): The Implications of Tradable Green Certificates for the Deployment of Renewable Electricity

2.4. What are you buying when you buy a Tradable Green Certificate?

It can be argued that renewable electricity has a number of 'values' to society, that each of these 'values' is a constituent of a TGC and that the priced value of each constituent should be able to be added together to give the total price of a TGC.

Among these 'values' we could include :

- increased diversity of national power sources;
- increased security of supply within the national system;
- avoided pollution from 'conventional' electricity generation (i.e. CO_2 reduction or reduced SOx and NOx emissions);

- the value of developing a new industry (e.g. new jobs, service skills, diversity of rural employment, export and manufacturing capabilities).

It should also be possible to establish these values and it should be clear to the buyer, which of the constituents they are buying. In practice, of course, it is much more complicated.

2.4.1. The 'Value' Formula

One way to view this is to consider the total value of greenness of the total social and environmental benefits as represented by the symbol V_G . This value can be divided into environmental impacts (V_E) and other impacts (V_{OTHER}), i.e.

$$V_G = V_E + V_{OTHER}$$

As the impacts represented by V_{OTHER} are of value only within the country of development, it seems unlikely that these components can be traded on international markets. However, they are valuable within a country (in the UK, for example) so any TGC system developed within the country could include these components.
This then means that the TGC traded within a country could be significantly different to that which is tradable in international markets.

However, V_E itself can also be split into two components: V_{CC} and V_{EOTHER}, where V_{CC} is the component of the value that refers to climate change benefits, and V_{EOTHER} represents all other environmental benefits of using RE-sourced electricity i.e.

$$V_E = V_{CC} + V_{EOTHER}$$

Once again, these 'environmental' components have quite different values in various Member States of the EU. This is because, for example, one unit of renewable electricity in one European country displaces a different amount of carbon dioxide than a unit in another country.

If trade is to occur, whether in the UK only or trans-nationally, a definition of the 'greenness' of TGCs has to be provided. This is much easier to agree on a domestic level within a national trading market than it is when trade takes place across national boundaries.

Thus, before international trade can take place a number of issues have to be agreed upon:

1. the definition of the perceived 'greenness' of the TGC, as this may differ between countries;
2. RE projects themselves may also have different 'green' impacts because of the variety of energy and environmental situations. These must be identified and agreed;
3. who receives the green 'credit' when buying a GC.

Box 2 : Key Questions
If the UK were to buy the green credits from a Greek wind farm, does that green wind farm effectively become a conventional power plant and so cannot be counted towards renewable energy deployment in Greece?

If the Greek wind farm displaced a certain amount of carbon dioxide, would that be credited in the country of redemption?

What about the local environmental value of that unit of electricity in Greece? That has no value to the UK which has bought the 'greenness' of the unit, but it does have some value to Greece.
Can Greece retain any of the local value of the 'greenness' and how should this be paid for?

Thus, there are serious problems to overcome if trans-national trade of TGCs were to occur. Nevertheless, there are benefits to such trade: these are listed below but are discussed in more detail in Chapter 5.

- Trade allows an obligatee to fulfil their obligation from a wider resource pool and therefore to have access to cheaper TGCs
- Trade allows an obligatee to purchase a greater number of units from a particular renewables resource (and this may also be cheaper, for example, photovoltaic electricity from Greece)
- Trade should lead to a more stable market (since with a greater resource pool to buy from there should be less chance of large price fluctuations)

3. How does a Trading System for Green Certificates Work?

In this Chapter we examine the basic design requirements for a TGC system, outline the key functions necessary for the operation of a TGC systems, examine some of the practical 'decision points' for TGC systems in the UK and review experience with TGC systems in other countries world-wide.

3.1. Design 'Fault Line'

From the technical perspective, establishing a national TGC system should not be too difficult. However, it is important to recognise a basic fault-line in the principle of designing the system. Whenever a decision has to be made, the design chosen can either complement the incentives to deploy or it can complement a least risk approach for the obligatees which have to fulfil an obligation. If the principle is in favour of deployment, then the key design decisions will be taken to ensure that it is always in the interests of those involved in the system to deploy. This is illustrated in Table 1.

Table 1 : Basic 'Fault Line' Questions

	TGC Designed to ensure deployment	TGC System Designed to Reduce Risk for Obligatees
Penalties for non-compliance	High	Low
Length TGCs remain valid	Limited	Forever
Banking and Borrowing	No	Yes
Maximum/Minimum TGC price	No	Yes

3.2. Accreditation and Standardisation

It has been clear for quite a while in the UK that RE electricity should be accredited, and this process is underway[4]. This is to enable consumer confidence in Green Power from voluntary supply schemes.

With a system of TGCs, a system of accreditation is also vital but in addition, standardisation becomes important. Within a voluntary green power market, a supplier can develop a tariff for (e.g.) solar electricity and sell it to a customer. It does not have to be standardised with any other unit of generation if the customer is happy to buy it.

[4] See publications and the website of the Energy Savings Trust for details of the 'Future Energy' scheme.

With TGCs, however, the entire trading system rests on the principle that there is equivalence between TGCs regardless of their means of production.
The system selected for TGCs could have a range of complexity, from a situation in which TGCs represent solely one unit of RE generated electricity to a more complex situation in which TGCs also represent a precise quantity of CO_2 abatement, linking price with pollution reduction. This should be agreed before a TGC market develops, whether on a national or a trans-national basis.

On a national level, an accreditation and standardisation body does not have to be linked to the Government. The recent response to the RE Consultation has said that OFGEM will be responsible for the system, but OFGEM could, and probably should, tender out this work to an independent company (We discuss the RE Response further in Chapter 4). Furthermore, the national system should complement any international (perhaps EU) system, which also does not have to be run by an EC body but can be an independent company. Clearly, if a political decision is taken never to allow a UK system to interact with trans-national trading[5] this does not matter. However, to say never in this situation seems unnecessarily inflexible.

Obviously, within a national TGC system, any TGC meeting national standards can be used to meet national quotas. However, international trading could take place between countries with different criteria. Trans-national trade clearly needs a sophisticated accreditation and standardisation body. This is more to do with information exchange and product security than with the tracking of the trade itself. It makes sense, therefore, that TGCs should hold as much information about the generation as is possible. This then allows purchasers to make the choice of what they consider to be 'green' or not green'. Voluntary 'green demand' may in addition come from consumers who, for example, do not accept energy from waste as an RE source, and who would only purchase Green Electricity if their power were guaranteed by TGCs from other RE sources.

3.3. Functions and Operation of TGC systems

To operate a TGC system, a number of functions (and/or bodies to fulfil them) are required.
These are :

1. Issuing certificates (i.e. an Issuing Body[6])
2. Verification of the issuing process (i.e. a Verification/ Accreditation Body)
3. Registration of certificates and trade (i.e. a Registration Body)
4. Exchange market (i.e. an electronic exchange)
5. Accounting of the certificates (i.e. an Accounting Body)
6. Withdrawing of certificates from circulation.

Once it has been decided what a Tradable Green Certificate *is*, so that it can be standardised, then the process of issuing a TGC, verifying it, registering it, buying

[5] Ultimately this would probably not be acceptable within EC Competition and State Aid rules
[6] Some of the functions in this list can be carried out by the same body, others must be carried out by different bodies (e.g. the verification and issuing functions).

it, selling it and redeeming it etc can be tracked electronically in a relatively easy way.

Around this (or these institutions) two other actors must interact: generators of renewable electricity (i.e. producers of TGCs) and the 'obligatee' or final purchaser of TGCs (in the UK instance, suppliers). It is to be hoped that other actors will develop to facilitate the trade: brokers; aggregators (who may also be brokers).
Moreover, it is also hoped that TGC systems will attract new entrants (as in generators, suppliers/energy service companies) increasing the diversity of actors in the electricity industry. It is also possible that non-conventional actors such as local authorities will become more involved, as the potential for them to do so becomes clearer.

At each point of the system there are several ways in which functions can be carried out and we do not cover all of these in this paper[7], but have selected the options we believe to be most practicable.

Issuing : TGCs are issued at the moment that electricity is registered at the kWh-meter.

Verification : Issuing bodies are accredited by the Verification body. Each TGC is unique and separately identifiable. A TGC can be represented by a paper and/or electronic certificate. TGCs may be assigned a unique number, which includes codes that identify the type of renewable energy source, the date of production, the owner of the green certificate, etc.

Registration : The 'whereabouts' of each TGC must be registered with the Registration Body, from the point of issue, through trades and exchanges to redemption/ withdrawal from circulation. This guards against 'double counting' and allows parallel operation of the RE obligation and voluntary 'Green Power' schemes.

Withdrawal from Circulation : TGCs are withdrawn from circulation at the moment that a customer accounts for their obligation by presenting the certificates to the body that imposed the RE quota.

Accounting, Exchange: Between issuing and withdrawing green certificates, TGCs are held in TGC accounts and can be traded. Each 'movement' of TGCs must be registered with the Registration Body. Accounting and trading of green certificates could be done by the generator of the certificates, but also by brokers, accreditors or directly with an obligatee.
The organisation of the green certificate exchange could be coupled to the electricity exchange, for example, or perhaps, in the future to a Carbon Allowance exchange, similar to the pilot exchange in Canada[8]. All these activities require proper registration and verification.

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[7] Readers who are interested in more detail should refer to the final report from the ALTENER study XVII/4.1030/Z/98-037 entitled "The Implications of Tradable Green Certificates for the Deployment of Renewable Energy" which covers the options in much greater detail. This is available from SPRU or from the ECN website at www.ecn.nl/unit_bs/ gr_cert.
[8] Bailey, D, 2000, Canada Tests Credit Trading Exchange, Wind Power Monthly, Jan, page 21.

It may also be necessary to address other issues as TGC systems develop. For example, it is not clear whether TGCs would be covered by Financial Services legislation, as they do not represent the provision of an energy service per se.

3.4. Key Decision Points

Apart from these institutional functions, there are many other issues that have to be addressed in order to make a system of tradable green certificates work properly, most of which are vital to its well-being.

3.4.1. Time Aspects and Flexibility Mechanisms

The time aspects of TGC systems are important as they can have a strong impact on purchasing behaviour and therefore on the price of TGCs. If there is a fixed obligation (or redemption) date each year, and there is a 'rush' to meet obligation targets as the deadline approaches, this will inevitably result in price hikes and increased market volatility.
In order to achieve confidence in RE markets (and therefore a more steady rate of deployment), the aim would be to reduce the potential for price hikes for TGCs. Although to some extent they are inevitable, they are more likely the longer the time between redemption dates and the shorter the redemption period. However, the 'smoothing' effect of frequent redemption dates must be balanced against the possibility of resulting higher transaction costs.

Set against this simple version of TGC systems, there are options for system 'flexibility' which can reduce such surges in price. These include:

'Banking' : where actors can 'store' excess certificates produced or obtained in one redemption period so that they can be used in future redemption periods. This is being considered in relation to Carbon Emissions Trading schemes.

'Borrowing' : where actors who have a shortfall of TGCs reduce their target in the current redemption period by adding to their target in future redemption periods. This is generally regarded as unacceptable, as it shifts the risk away from the obligatee.

Rolling Redemption Periods : Actors could meet their target over a period of, say, 5 years. In this way, their total target for TGCs would be 5 times the size of an annual target, but they will be allowed flexibility in how they meet it, so that years with, say, low wind levels, can be offset by years with higher wind levels. A similar framework has been proposed for the Kyoto Protocol. Of course, unless this is designed correctly, it could result in an enormous price hike at the end of the 5 year period, so it will require rolling deadlines and devices such as 'intermediate targets' for each year etc.

Ministerial Powers : In Denmark, the proposed TGC system contains reference to a Ministerial power that allows government to waive (or reduce) the target in any one year, if, for example, there are low resource levels or any other unforeseen circumstances.

TGC Expiry Dates : TGCs can be designed so that they must be used within a certain time period after their production (i.e. they have an expiry date). The date

can be set to encourage rapid deployment (short TGC lifetime) or to reassure the market (infinite TGC lifetime) etc.

3.4.2. Penalties and Price Caps

Price-caps and penalties, while separate design characteristics, are often used for the same purpose. A TGC system will not work if there is no penalty for failing to meet the obligation. The need to enforce a penalty for non-compliance of an obligation is a particularly sensitive issue. This has two main aspects:

1. the size of the penalty, and
2. how to enforce it.

Rader pointed out that one reason why the sulphur emission trading system has been so effective in the US is because the penalties have been so high. It costs about 100$ for a 1 tonne sulphur certificate, while the penalty is about 2000$. In this situation, the trading system works. However, penalty systems can effectively be set up to condone a certain amount of non-compliance, whereby penalties feed-back into the system and may be used, for example, to subsidise the more expensive renewable energy technologies.

TGCs can exist with no price cap. This means at the time of redemption, the obligatee will be required to pay whatever price of TGC is necessary to meet their obligation. The penalty for not meeting that obligation should therefore always be higher than the highest price paid for a TGC. One way to do this is to have the penalty as a flexible additional cost - i.e. TGC + X, where X is the penalty over and above the market price. In this situation, it is always in the interest of the obligatee to fulfil their obligation.

However, it is also possible to set a price cap on TGCs. This fulfils a number of functions:

- It sets a maximum price that obligatees have to pay to fulfil their obligation. This may have political merit both from the perspective of the Government which may not wish to be seen to be placing excessive costs on suppliers but also so that anti-renewable lobbyists are unable to say that renewable electricity costs an exorbitant amount;
- It also excludes certain technologies because their unit price would be above the limit. This may also reduce customer choice.

The recent Response to the RE Consultation indicates that the UK will allow a buy-out of the obligation. This means that OFGEM, who is to administer the obligation, will set a buy out price. This price (the response mentions about 2p/kWh) effectively sets the price cap. When GCs cost more than this, suppliers may choose to 'buy-out' of the obligation at this price. If suppliers do decide to buy renewable electricity, the CCL will also increase the effective price cap for renewables.

The penalty, or buy out price, can be recycled in a number of ways, each of which has implications for the UK. There is a broad division of options: either the penalty money can be reimbursed to suppliers who meet the obligation, thereby

reducing their costs and rewarding 'good behaviour' or the penalty money can be diverted to a pool which can be used to promote the more expensive technologies. The RE Response has chosen to go down the former route. Another alternative may be a 'half and half' measure whereby half the money is reimbursed while diverting the other half to benefit the more expensive technologies.

With trans-national trade of TGCs, other issues become prominent, such as how to penalise non-compliance which is caused by defaults by non-national actors. See Box 3 (below).

BOX 3 : Example of TGC Penalty Issues

For example, a UK company has contracted to buy TGCs from France and, for whatever reason, those TGCs are not forthcoming. Which companies should be penalised in this situation? The UK company because they have not met the TGC obligation? or the French company because, despite a valid contract, they did not provide the TGCs?

Furthermore, who should enforce that penalty. A UK body for the UK company is fairly sensible but should it also be the UK body which tries to enforce a penalty on the French company? Does this mean that there has to be a Euro-wide penalties office?

If a company will not pay its penalty, what sanctions can be imposed. Would this be the same throughout Europe? For example, if one country's penalties were more lax than another country's, one could imagine that given a problem of supply that a generator would choose to supply the company facing tougher penalties (which may be willing to pay a higher price) rather than the company in a country with less tough penalties. In the long term, of course, this would be smoothed by the operation of the market, but it could result in short-term failures to meet RE targets.

3.4.3. Reference Point for Target Assignment

There are questions relating to how the obligation is set. The 10% target can be calculated relative to a reference year (e.g. 1990, the reference year for CO_2 reduction targets), a supplier's total for the previous year (this is known as 'grandfathering'), or in various other ways[9]. The target setting process should take into account the actions that actors have already carried out in anticipation of their target, and allow for new entrants into the market.

3.5. Experience so far

While many countries in the EU (e.g. Germany, Finland, the UK) already have some form of 'Green Electricity' supply, other countries have also initiated (or begun to initiate) TGC systems. In this section we review some of the experience with TGCs so far.

[9] For further details on how obligation levels can be set, see Schaeffer, G.J., M.G. Boots, T. Anderson, C. Mitchell, C. Timpe, M. Cames (January 2000*): The Implications of Tradable Green Certificates for the Deployment of Renewable Electricity*

3.5.1. The Netherlands

A system of TGCs (known as the 'Green Label' system) was set up in the Netherlands in 1998 by the Association of Dutch Energy Distribution[10] Companies (EnergieNed).
Although this was an electricity sector initiative, the government of the Netherlands has also introduced a new Electricity Act that gives it the option of introducing compulsory RE quotas with TGCs after 2000 if the sector initiative is not delivering the required amount of RE deployment.
The Green Label system replaced a support system for RE that was based on tax rebates and subsidies from 'distribution' companies (equivalent to supply companies in the UK). The subsidies were based on RE project cost and funded by a small supplement on the electricity price (called the MAP-supplement).
Dutch electricity distributors are required to pay a 'regulating energy tax' (REB[11]) on total electricity consumed to the fiscal administration, but RE is exempted from this.

The Dutch certificate system aims to achieve a target of 1.7 billion kWh electricity produced by renewable energy sources in the year 2000. This is the first binding target in the system, and until that date the distributors can gain experience with trading 'Green Labels'. It is predicted that trading will not develop fully until later in the year 2000, when distribution companies have to meet their first binding target.

The targets were set by allotting each distribution company a minimum target (quota) for electricity from renewable sources, based on their sales volume in 1995. Distributors have to hand over 'Green Labels' (i.e. TGCs) to meet their quota.

Producers of electricity from RE generation receive one 'Green Label' for every 10,000 kWh electricity produced from renewable sources. Distributors and customers who generate their own electricity from RE sources are also eligible to receive 'Green Labels' for this. If their RE generation exceeds their obligatory targets, they can capitalise on the difference by selling their 'Green Labels'. This is intended to encourage further production of electricity from RE by private individuals and companies.

The penalty level for failing to meet RE quotas is set at 1.5 times the market price for 'Green Labels'. This ensures that a price cap is not fixed.

Since the end of 1998, EnergieNed has taken several initiatives to explore how the 'Green Label' system could be internationalised. The first 'international trade' in TGCs or 'Green Labels' took place in 1999 between the Dutch utility ENW-NUON and the British Company, National Wind Power. This prompted much debate with the Netherlands and resulted in a proposed modification of the Dutch TGC system so that trades in TGCs from outside the country must be matched

[10] In the Netherlands, 'Distribution' companies are equivalent to a combination of UK Distribution and Supply companies.
[11] Like the Climate Change Levy, the REB was set up to encourage energy savings and not primarily to support the use of energy from RE sources.

by a simultaneous trade in physical electricity. This is, of course, directly contrary to one of the main reasons for introducing TGCs in the first instance i.e. the flexibility allowed by detaching the 'greenness' from the physical electricity.

A review of contracts set up so far under the Netherlands system also reveals that most TGCs are traded in long-term (5- 10 year contracts), with very few traded in short term exchanges. It also seems likely that there will be a shortfall of 'Green Labels' at the end of 2000, the first compliance period, as current deployment will not meet production targets.

3.5.2. Denmark

On 3rd March 1999 the Danish parliament agreed to a new Danish Electricity Act which sets out the way in which RE will be promoted via an obligation on electricity consumers coupled with a TGC system. The obligation was set at 20% of electricity supply by 31 December 2003. It has recently been announced that this will be delayed by at least two years.

Denmark currently produces around 10% of its electricity from RE and has ambitious deployment aims for both onshore and offshore wind power installations which it hopes will allow it to achieve this target.
Danish TGCs will be issued for electricity produced by wind turbines, biomass, solar cells, geothermal plants, small hydro-energy plants (<10MW) and 'new renewable energy technologies' (energy from waste is not regarded as renewable in Denmark).
Production from existing RE generation that has already been supported by other instruments will not be awarded certificates.
It is likely that most consumers will contract with suppliers to meet their obligation.

The Danish system is underpinned by a guaranteed minimum price for TGCs. This is set at 0.10 DKK/kWh (0.014 Euro/kWh).
For years up to 2003, intermediate obligations are to be announced, and the government has allowed itself the right to reduce the commitment to purchase if the development of new schemes does not result in the necessary amount of production in any one year. After 2003, the Energy Act states that obligations on consumers will continue to play an important role, possibly besides other measures, although the post-2003 targets have not yet been set.
If a consumer fails to meet their purchase obligation they have to pay a penalty of 0.27 DKK/kWh (0.037 Euro/kWh). This fixes a maximum price for TGCs within the country.

3.5.3. Belgium

The Flanders region of Belgium has recently proposed a TGC system in which an obligation is placed on suppliers to meet a percentage of their supply from RE generation. It is likely that this system will be in operation by 2001. The Wallonia region has not yet followed suit, but has set up a study to evaluate the potential for TGCs within the region. This study has proposed four main objectives should be designed into TGC systems:

1. Diversity of RE supply (e.g. by having technology bands or 'baskets' within the overall quota)

2. Preserving the 'polluter pays' principle (they suggest that this can be done by excluding 'polluted biomass' i.e. municipal and industrial waste)
3. Introducing environmental competition (by linking each RE technology with a global life cycle analysis of its CO_2 emissions)
4. Limiting the volatility of the TGC market (by setting out levels of guaranteed minimum prices and penalties i.e. maximum prices).

3.5.4. Italy

The Italian government is currently preparing legislation on future support for RE. An obligation of a 2% quota of electricity from RE sources came into force in April 1999, and it is expected that the forthcoming decree will set out the way that TGCs can be used to meet this quota.

3.5.5. RECS

A number of utilities from the Netherlands, Denmark, Germany and the UK, under the acronym RECS (Renewable Electricity Certificate System) have begun to work towards international green certificate trading. A first pilot trade in green certificates took place in early 1999 between National Wind Power (UK) and Energie Noord West (NL). This has been overtaken to an extent by individual countries setting up their own schemes. However, since RECs is made up of utilities which are likely to be obligatees, the principle upon which their design is based may (but of course, not necessarily), be linked to risk-reduction. This is in contrast to the point made earlier, that TGC system design should be based on increased RE deployment, which will be a tougher regime for obligatees. Table 2 shows an overview of Green Certificate activities in the EU.

Table 2 : Overview of green certificate activities in EU Member States

	Activity at the level of		
Country	Government / legislation	Electricity sector (and/or RECS)	Consumers (green pricing)
Austria			
Belgium		✓	
Denmark	✓	✓	
Finland		✓	✓
France			
Germany	(✓)	✓	✓
Greece			
Ireland			
Italy	(✓)	✓	
Luxembourg			
Netherlands	✓	✓	✓
Portugal			
Spain			
Sweden			✓
UK	✓	✓	✓

3.5.6. The USA

In the USA a system known as the 'Renewables Portfolio Standard' (RPS), which is similar to TGCs, has been proposed for the support of RE in several states. The system includes a percentage RE obligation placed either on generators or retail sellers and allows trade of 'Renewable Energy Credits' (an entity equivalent to a TGC) to allow flexibility in meeting RE quotas. So far the approach has been adopted in eight states as part of electricity restructuring legislation. There are also 5 RPS bills pending in the US congress. See N. Rader's papers or some of the US Green Power websites (such as www.eren.doe.gov/greenpower) for further discussion of these topics.

4. Implications of a Tradable Green Certificate System for the UK

The UK has announced that it will have an obligation on suppliers to meet 10% of electricity supply from RE, if possible by 2010, using TGCs. The key elements of the recently announced (Feb 2000) Response to the RE Consultation are:

- Progress is to be made towards a target of generating 10% of electricity from renewable sources by 2010;
- this can be undertaken through the purchase of TGCs;
- 5% is to be reached by 2003; 10% by 2010;
- evidence of compliance will be monitored by OFGEM (or an agent);
- the period of obligation is expected to apply until 2025;
- it is possible to 'buy-out' of the obligation by making a payment to OFGEM;
- buy-out payment receipts are to be discussed but possibly recycled to suppliers that meet the obligation;
- the intention is to place an equal obligation on all suppliers;
- large-hydro over 10MW may be excluded;
- NFFO1 and 2 generation will be eligible for the obligation;
- dual-fuel plants are eligible for renewable portion, as is CHP fuelled by RE;
- a green certificate is equivalent to a unit of electricity;
- non-domestic consumers will be exempt from CCL when GC is attached to the physical unit;
- it is expected that spot, forward and derivatives markets of GCs will develop.

The Response paper has not set out the flesh to these bare bones but there are a number of options for TGC trade. These are :

1. Trade within the UK only;
2. National and trans-national trade where sales of TGCs transfer only the CO_2 credit to the country of redemption, leaving the renewable energy deployment credit with the country of production;
3. National and trans-national trade where sales of TGCs transfer both the and CO_2 and renewable energy deployment credits to the country of redemption.

4.1. General Introduction to UK Issues

This section will describe the key ways in which TGCs could be used within the UK. These are :

1. GCs alone or GCs + kWh together which can be used against the obligation;
2. Combined GCs and kWh for CCL rebate (small business users), also eligible against the obligation;
3. Combined GCs and kWh for 80% exemption from the CCL (large business users), but not eligible against the obligation (not yet agreed by HM Customs and Excise and DETR)[12];

[12] Large business users qualify for the CCL exemption by pledging to undertake additional emissions reduction measures. TGCs used to qualify for this should not therefore also be used to meet the obligation.

4. GCs alone or GCs + kWh together which are used with voluntary Green Power supply, which cannot be used against the obligation.

Not only does the system become much more complicated as soon as trade occurs trans-nationally but it also has wider implications for the UK. On the whole, international trade brings the benefits associated with a wider market, but may also impact on the diversity of RE technologies developed. This is discussed further in section 5.2.6.

4.2. Climate Change

To date, RE policy and Climate Change policy have operated in parallel, but the setting of ambitious greenhouse gas reduction targets has prompted increasing closeness between the two sectors and interest in the role of RE in greenhouse gas reduction.

As far as UK policy is concerned, there are two key options for the interaction of TGC systems :

1. Interaction with Climate Change Levy;
2. Interaction with Carbon Emissions Trading.

The extent to which renewables are linked to Carbon Emissions Trading depends on the design of the TGC system and this is discussed below.

4.2.1. Interaction with Climate Change Levy

A Climate Change Levy (CCL) is to be levied on business customers with effect from April 2001. The recent pre-budget announcement (Nov 1999) stated that renewable generation would be exempt from it which makes RE more attractive (on a cost basis). However, under the current rules proposed by HM Customs and Excise, rebates on the CCL will only be considered if trade in TGCs is matched with trade in physical electricity.

If international trading in TGCs were to be allowed, this means that only TGCs generated and redeemed in the UK would qualify for the CCL rebate. In such a situation, the Government would be able to argue that the CCL, paid for by British Business, should not be used to subsidise European renewable energy companies.

The pre-budget announcement also stated that large users of energy would be able to negotiate an 80% reduction in their CCL by pledging to voluntarily reducing their greenhouse emissions. It is not currently clear whether they are allowed to do this solely by energy efficiency measures or whether they can pledge to use 'Green' electricity (i.e. RE electricity that is additional to that covered by the obligation on suppliers) [13] in order to qualify. It would clearly benefit sustainable energy if this were possible.

[13] Combined Departments of UK Government, Scottish Executive, the NI Department of Enterprise, Trade and Investment and the National Assembly of Wales, 1999, Consultation on Energy Efficiency Measures Under the Climate Change Levy Package, Dec.

4.2.2. Interaction with Carbon Emissions Trading

The government could determine that electricity from RE has a value to Climate Change targets that is expressed by a quota of carbon 'released' from a tradable allowance. This means that by purchasing or using electricity from RE sources, an actor can release part of their allowance to emit CO_2, which they can then use or trade in a Carbon Emissions Trading (CET) scheme. This can operate alongside a system of rebates on the CCL or be separate from such a system. Moreover, it could operate alongside, or be part of, a TGC system. Interaction with CET system is already emerging in several countries worldwide (such as Sweden, Denmark and Canada).

The linkage between TGCs and CETS could occur as a derivatives market, which would require that the initial GC issuing body establishes, or at least, has the ability to establish, how much CO_2 (or other pollutant) is displaced by the GC. This issue of 'splitting' the greenness of RE into components is important both for the proposed UK Emissions Trading System and also for trans-national trade.

4.3. The Voluntary 'Green Power' Market

Arguably, the voluntary market will do best when there is no other support mechanism for renewables. This is because green-minded people may be prepared to sign up for a green tariff when there is no Government support but not be prepared to do so when there is, reasoning that they are already paying for the obligation. Thus, there is concern that a TGC system will undermine the voluntary market.

In the first instance, under a TGC system with an imposed obligation for renewable energy supply, the state has decided how much renewable electricity is to be generated and paid for by the totality of electricity consumers. However, it is possible (and to be expected) that some customers would like to buy a greater share of their electricity from renewable sources than is defined by the obligation.

Moreover, TGCs can also be used by Green Power suppliers to demonstrate proof of generation to their 'green' consumers i.e. TGCs can be used to show that both imposed and voluntary demand targets are met. Clearly, accreditation and auditing must be set up to ensure that each TGC is used only once, i.e. either to meet the obligation or to meet extra demand from 'green' consumers. This ensures that no double counting of RE generation takes place but also that all suppliers are affected equally by the obligation.

An exemption of 80% of CCL payments for large businesses in return for a pledge to reduce their emissions by buying renewable electricity would be an important boost to the voluntary green market.

4.4. Key Uses for TGCs in a UK only system

Figure 3 (over) sets out the key potential uses of TGCs in the UK. It can be seen that the generation from a renewable energy power plant divides into three streams after its metered output has been issued with GCs:

1. units of physical electricity (kWh);
2. Green Certificates (GCs);
3. Green Certificates that are contractually linked to their physical units of electricity (GCs & kWh).

4.4.1. GCs combined with kWh

As the RE Response states, HM Customs and Excise have only agreed to CCL exemption for electricity which is contractually linked to its GC. Thus, combined kWh with GC can follow two main routes:

1. Sale to a small business customer, that will be able to claim a rebate on the CCL;
2. Sale to a large business customer which will be able to negotiate an 80% exemption on their CCL bill if they pledge to reduce their emissions by using renewable energy sources[14].

These two options may occur via a supply company or via licence-exempt supply.

4.4.2. GCs alone

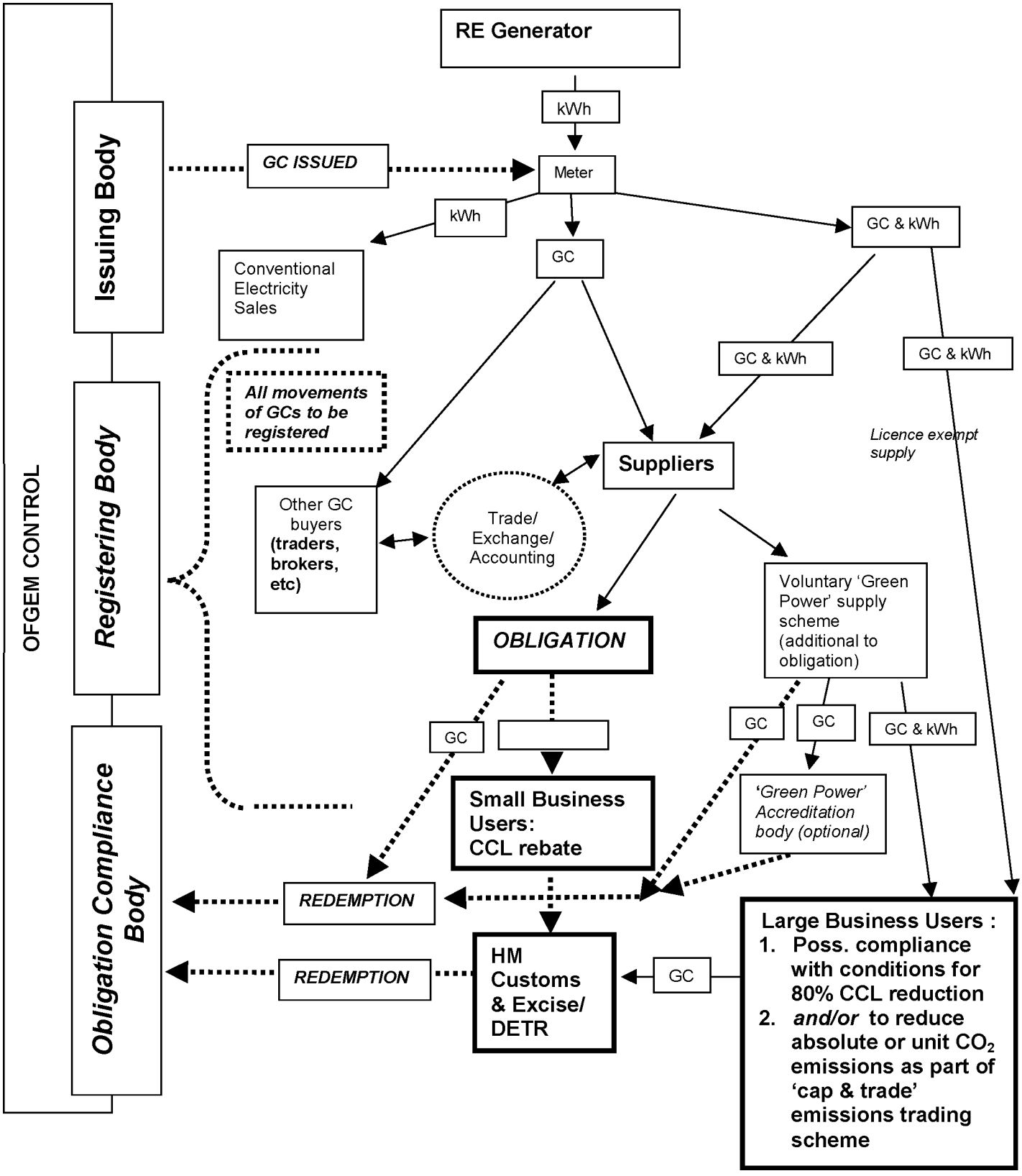
As Figure 3 shows, GCs could also be traded within the TGC market in isolation from physical electricity. In this situation, they can

- become involved in trade, (e.g. in a futures and options market), and then be returned to a supplier who will sell them to fulfil their renewables obligation;
- be sold directly to the renewables obligation;
- be sold to the voluntary market.

If a GC is sold into the voluntary market, we recommend that it is redeemed so that a net balance is maintained between GCs issued and surrendered, thus ensuring the transparency of the system.

[14] if this is allowed under the proposed scheme.

Figure 3 : Interaction of RE Obligation with Voluntary 'Green Power' market, Climate Change Levy and Carbon Emissions Trading



4.4.3. Units of electricity (kWh) alone

When a certificate is sold in isolation from the physical electricity, the 'greenness' of this unit of electricity has been taken away so it has effectively become 'brown' electricity. This electricity is then sold in the normal manner.

4.4.4. Registration

At all points of trade, the registration body has to be notified to ensure no double counting occurs.

5. International Trade

While it is relatively simple to set up a domestic TGC system, the possibility of international trade in TGCs (say across the EU or in a smaller bubble) introduces a new set of benefits and disbenefits. A number of key issues have to be agreed on by all members of the bubble. However, the European Commission Directive on Fair Access to the Grid (which is expected to emerge in draft form soon) may constrain national wishes.

5.1. EU Policy Drivers

The European Union (EU) influences the development of renewable energy policy in the UK as well as other European countries. The EU has signed a legally binding agreement to a 8% reduction in a basket of six emissions in the commitment period 2008-2012 as a result of the Framework on Climate Change Convention (FCCC). The deployment of renewables is a central tool for the EU in meeting this target.

The European Commission has published a number of papers concerned with renewable policy over the last few years (See Reference section). The EU White Paper for a Community Strategy and Action Plan proposed a target of 12% of energy supply from renewable resources by 2010. This is a doubling of energy supplied from renewables in the EU. Much of this current European supply is derived from large hydro and traditional biomass. Some European countries, for example Austria, considerably exceed the 12% of energy supply target yet only supply a small percentage of it is from 'new'[15] renewable resources. The UK, on the other hand, provided only around 2.5% of its electricity supply from RE sources (1998 figures) and therefore has a very long way to go to reach the 12% target, most of which will have to be derived from 'new' renewables. Clearly, much negotiation will take place as each country agrees its own commitment to this proposed target.

The extent to which the EU is able to promote their policies within Member States is crucial. From the publication of the White Paper in 1997 to the current debates over the merits of a Directive on Fair Access for Renewables to the Electricity Grid, a fundamental shift has occurred within the European renewable energy policy world. This has led to the central power force behind renewable energy policy moving from DG12 (R&D) and DG17 (Energy Policy) to DG4 (Competition) and DG17 (Energy Policy). As the timetable for the Single Electricity Market (SEM) moves closer, it has become clear that renewable energy policy is expected to be complementary to the principle of a SEM. Thus, while the White Paper concentrated on targets (12% of energy by 2010) and how to get there, the Draft Directives have been explicit in their support for competition as the basis of promoting renewables and of the need for individual Member State renewable energy policies to meet the EU Competition and State Aid requirements. Thus, the position of renewables within Europe has altered dramatically within a couple of years: renewables within European Commission

[15] 'New' renewables is a recognised term for renewables which are deployed as a result of promotional mechanisms and which exclude large hydro and conventional biomass.

policy, as with renewables in the UK, are expected to fit with the move towards a competitive single market.

The key driver at the moment is a Paper (either known as a Working Paper or a Draft Directive) which has been in development for a year. It is intended to become a Directive on Fair Access for Renewables to the Grid in a Liberalised Market. It derives from the need for renewables to fit in with the Single Electricity market. Under State Aid rules, renewables should not be the beneficiaries of different promotional mechanisms in different countries since that would give the country providing the support with a competitive advantage over the countries which do not give the support. The key to the Paper is to know to what degree subsidies are acceptable; when all countries have to open up their subsidies to other countries and when subsidies have to finish. First indications are that countries will be able to support the development of their domestic RE industries only up to a certain level, after which they must be opened to non-domestic market actors.

The first indications are that :

1. Subsidies do not have to be opened up to non-domestic power plant owners until 5% of electricity (energy) supply is reached in that country (and in any other country with which trade of RE takes place);
2. Subsidies are acceptable until renewables provide 10% of energy supply or 2010 whichever comes first.

A final decision on this will have major implications for a future renewable energy policy. This is as yet unclear; nor is it clear what the timetable for clarity is.

5.2. Key Issues

5.2.1. What is traded?

It is important to be clear about what is being traded when a TGC is bought. What does a green certificate comprise? Some countries may want to trade units of renewable electricity to meet an obligation without linking them to reduced emissions. However, it is clear that one main impetus for international trading of TGCs is likely to be the introduction of Carbon Emissions Trading schemes. As a result, other countries may argue that a TGC should represent, at least in part, some measure of Carbon Abatement. However, as a kWh from an RE scheme displaces vastly different amounts of CO_2 in different EU countries, then just how much CO_2 abatement will each TGC represent?

5.2.2. Links to Physical Trade

Some countries have stipulated that physical electricity should be linked to the GC. This is mainly a mechanism to ensure that the benefits of the TGC remain in the country or that a subsidy benefits the domestic country and not a trans-national customer (as in the case of CCL exemption in the UK). Intuitively it would seem that there should be an impact on the network if all UK GCs are sold out of the country, leaving the physical electricity to be sold in the UK. However, it turns out that this is more of an economic than a technical impact. The physical electricity will all be sold, but possibly at a lower price than wished for.

However, from a technical point of view, in terms of absorption of physical electricity, there should not be a difficulty for the network.

5.2.3. Which country receives the credit?

If there is sale of a TGC, with no link to a sale of physical electricity but incorporating the CO_2 displaced in the country of generation, which country receives the 'credit' for the TGC? What happens if the TGC is produced in a country with a higher CO_2 density than the country of consumption? Is there any 'stray' CO_2 abatement, and which country is entitled to claim it against their Climate Change targets? This is obviously complex.

Key decisions must also be taken as to whether the sale of a TGC represents the sale of CO_2 benefits alone, or incorporates other 'credits'.
For example, if the UK sells a TGC to another country, then it can be reasonably assumed that the UK obtains neither the international pollution benefits nor can it count the units sold towards their renewable obligation. However, it does in fact retain more local pollution benefits, increased security of supply/diversity in its electricity supply system and new business for the renewables industry etc. Does this therefore mean that the credit for the capacity deployment of renewable energy remains in the UK? In theory, of course, these two credits can be 'split' (for example, it is possible for the UK to retain the credit for deployment while releasing the credit for CO_2). Decisions on these issues must be taken at the political level, in agreement with potential trading partners.

5.2.4. What happens to subsidies?

If one country produces more competitively priced TGCs than others, it will gain a greater share of the market. However, what happens if the TGCs are competitive because they have been in receipt of some form of subsidy? Are the subsidies refunded to the government at the border, thus raising the price of the TGCs to non-domestic customers/suppliers. This would promote the domestic market. What happens to 'subsidies' which are indirect, such as favourable grid access, rebates on CCL-type taxes or electricity trading system conditions? The refunding of subsidies would not normally be expected of other products which are also in receipt of subsidies, such as agricultural products. However, renewable energy may be a different case because of the European Directive, at least in the short term[16].

5.2.5. Trading Configurations :

There are two main configurations to consider :

1. Trading by UK companies in a green bubble or non-harmonised EU - system
2. Trading by UK companies in centralised Euro system

Arguably, the 'Green Bubble' option seems most likely to happen in the next two or three years. This represents a situation in which an international group of

[16]European Commission (1999): *Electricity from renewable energy sources and the internal electricity market.* Working Paper, Brussels, 1999.

bodies (which could be public or private companies) make an agreement to trade TGCs with each other. It is important that any non-participants to such a system have a chance to influence its design so that it does not disadvantage them in the future.

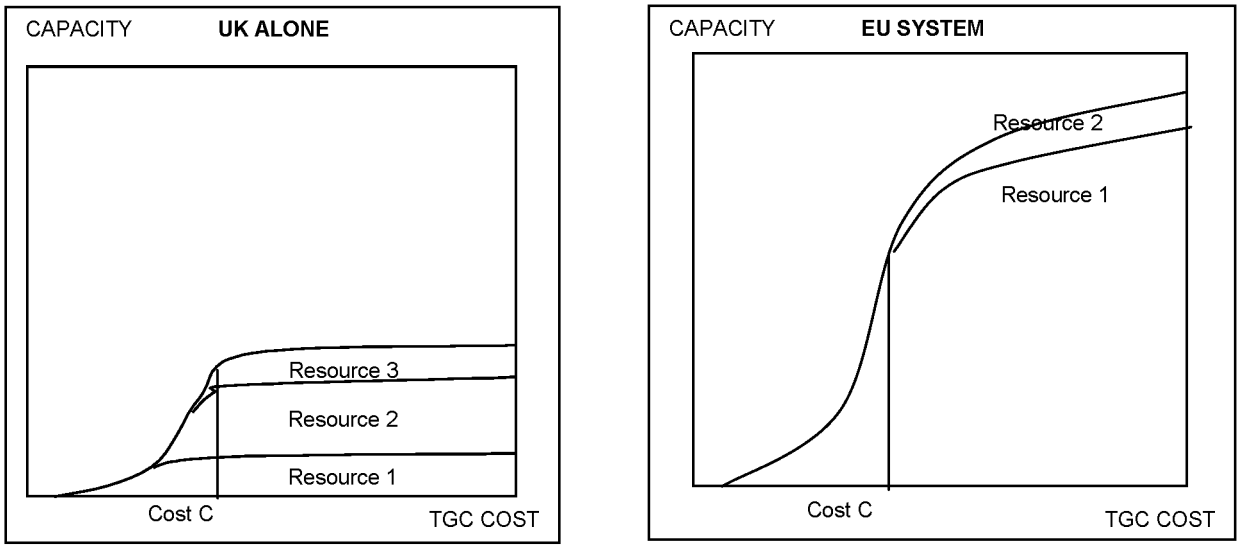
5.2.6 Impacts on Technology Diversity

It is likely that international trade in TGCs would have impacts on the diversity of technologies deployed (internationally) in order to meet RE targets.
The key issues are :

- The cheapest TGCs would be bought but these would be from a bigger pool, for example a 'bubble'[17] of countries or the EU, which means that UK suppliers could fulfil their percentage obligation at lower cost.
- This means that the more expensive technologies in the UK will not be developed until the cheaper technologies throughout the bubble have been fully exploited.
- It may be that UK RE generation is cheaper than that of other countries and therefore there may be a bigger market for UK renewable energy generators, and hence TGCs.
- As voluntary demand increases or as particular supply tariffs develop, it may be that specific EU-wide tariffs develop for specific energy streams. (For example, Spain could develop a specific RE supply stream based on energy crops, or solar PV).

In the UK a set of 'Resource Cost Curves' is often used to express the relation between RE capacity available and its cost. We can use this same device to show the impact of trans-national trade. As Figure 4 shows, if the UK remains isolated from trans-national trade, it can expect to promote more technologies at cost C, but if it joins trans-national trade it can expect to access a bigger resource at cost C but to promote fewer technologies.

Figure 4 : Conceptual Resource Cost Curves



5.3. Impacts of Other Support for RE

5.3.1. Combining TGCs with Voluntary Green Power Purchases

Where there is international trade between two countries, one of which has voluntary Green Power schemes, and one of which does not, the voluntary demand from the first country raises the international equilibrium price for TGCs and leads to higher deployment of RE in both countries.
We set out the theoretical basis for this in the box below.

BOX 4 : Theoretical combination of International TGCs with Green Power Schemes

Consider two countries, country A and country B, where country A has higher demand for TGCs because of voluntary schemes for the sale of Green Power. As the figure below shows, the voluntary schemes in country A raise the international equilibrium price for TGCs, because the new renewable electricity target is the sum of the obligations in the countries A and B *and* of the generation demanded by the voluntary customers in country A.
This in turn leads to a higher level of renewable electricity generation in country B, while the resulting generation in country A (Q_A'') is dependent of the shape of the MC curves.

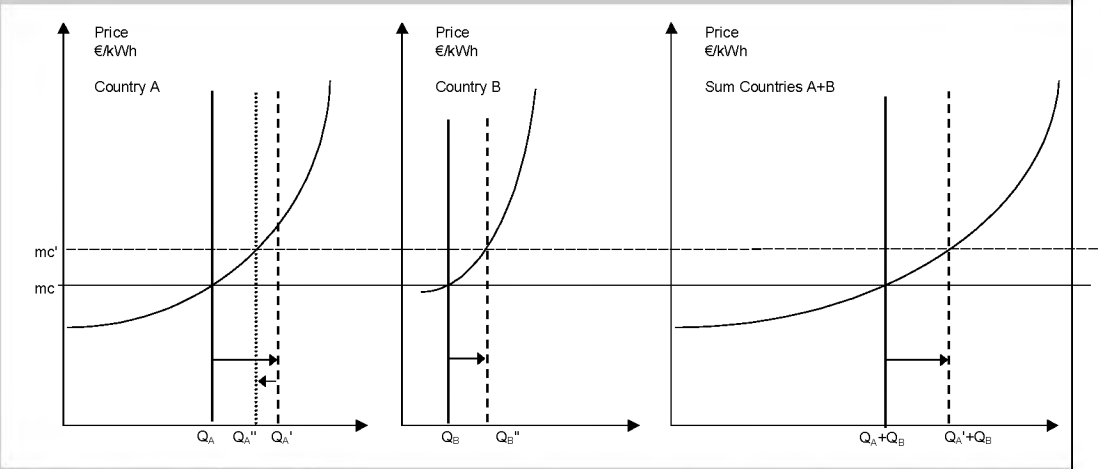


Figure 5 : International effects of a combination of a TGC system and voluntary "Green Pricing"

Key :

- Q_A : *size of quota for RE in country A;*
- Q_A' : *size of total demand for RE in country A, (quota plus voluntary demand);*
- Q_A'' : *size of total demand for RE from country A, (quota plus voluntary demand minus RE sourced from country B);*
- Q_B : *size of quota for RE in country B;*
- Q_B'' : *size of total demand for RE in country B (quota for B plus demand from country A);*
- *mc : marginal cost of developing quantity of RE to meet quota Q (in A or B);*
- *mc' : marginal cost of developing quantity of RE to meet quota Q plus voluntary demand..*

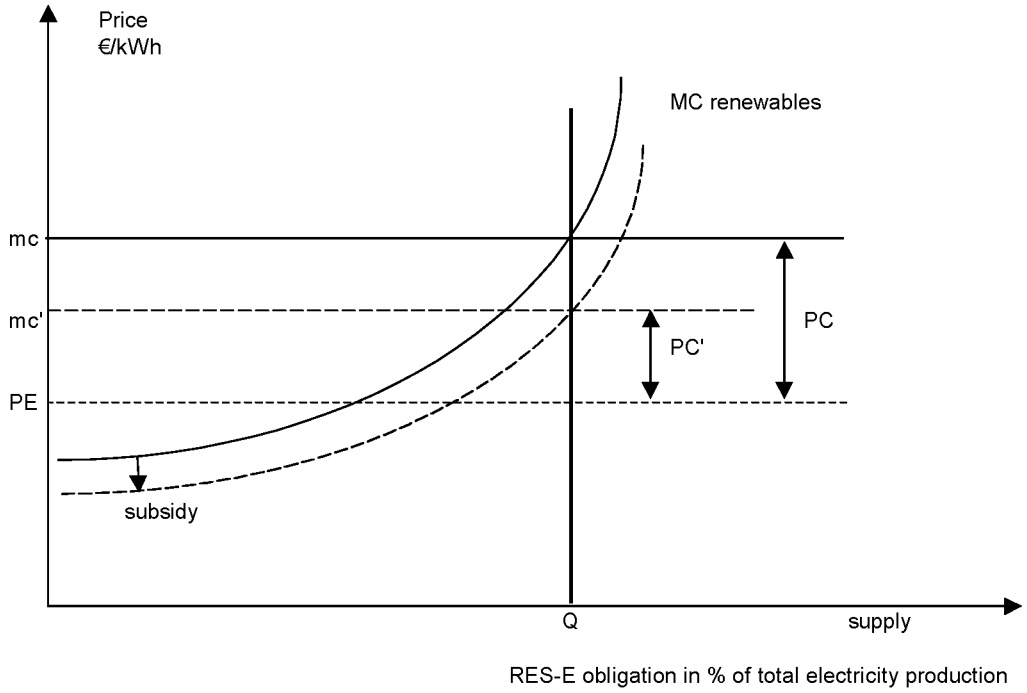
[17] a 'bubble' is a group of countries which have agreed to standardise their definitions of TGCs

5.3.2. Subsidy

Subsidies (which are taken to mean any other support whatsoever for RE, including technology-specific capital grants, tax breaks, subsidies such as the NFFO and fixed payments such as those that occur in Denmark and Germany) can result in several effects on TGC system behaviour.

If a subsidy is given to all generators of RE electricity without specification, then the price of TGCs will be reduced by the value of the subsidy per kWh. The subsidy does not expand the economic potential of RE electricity production (from the investor's point of view), as there is a pre-defined obligation.

Figure 6 : Combination of a TGC system and investment subsidies



Key:

MCrenewables = marginal production cost curve of electricity from RE sources
Q = Obligation target
mc = marginal cost of meeting target Q
PE = market price for electricity
PC = Price of TGCs (i.e. mc-PE)
mc' = mc-subsidy

If the subsidy is given to specific investors, this also leads to a reduction of the price of the certificates (see Figure 6) and not to an expansion of the renewable electricity generation. For example, if capital grants were given to those technologies which were not expected to be competitive within the TGC system alone, it would promote diversity amongst RE technologies deployed, rather than increase the amount of deployment per se.
If the subsidy were to reduce the marginal costs of the subsidised plant, then other power plants would be driven out of the TGC market at the expense of the inclusion of the subsidised plant.

As we mentioned above, a national TGC system is much easier to develop than a trans-national system. However, as liberalisation of the energy markets unfold across Europe, it seems likely that some sort of trans-national interaction is inevitable. Understanding the implications of this is sensible, even if the UK decides that it wishes to be involved in a national system only.
Figure 7 (below) shows the interaction of an international TGC system (represented by two countries A and B) with a subsidy in country A.

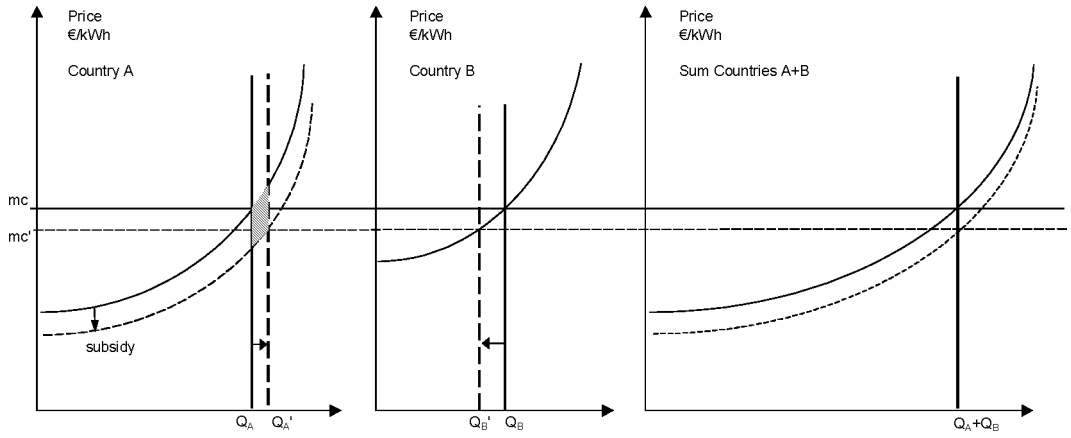


Figure 7 : International effects of a combination of a TGC system and investment subsidies

As can be seen from the figure, a subsidy in country A leads to a shift downwards not only for the marginal cost curve of country A, but also for the MC curve for the sum of renewable electricity potentials of countries A and B. From the intersection of this curve (in the right part of the figure) with the sum of the obligations Q_A+Q_B, the new equilibrium price for renewable electricity in both countries results. As the figure shows, this leads to a smaller renewable electricity generation Q_B' in country B and a higher generation Q_A' in country A. The subsidy therefore leads to a shift in the regional allocation of investments.

On the other hand, those who pay for the obligation in country A are subsidising not only the price of the certificates in their countries but in all countries participating in the TGC system. In the figure above, the subsidy in favour of consumers in country B is proportional to the hatched area.

This makes clear that investment subsidies under a TGC system should be targeted very precisely to technologies of special interest and should have a total budget significantly lower than the volume of the TGC market to avoid severe market distortions.

With respect to tax rebates or eco-taxes, the interaction of them with a TGC system is in general quite similar to the effects of investment subsidies.

This has serious implications for a country which wishes to promote renewable electricity and which also wishes to undertake international trade.

Thus, for a UK TGC system to work as well as it should in theory, a number of requirements have to be in place:

- Transparency
- Cost-reflectivity
- Fully tradability – i.e. trade of TGCs is not linked to trade of physical electricity (which introduces physical constraints)

If, in addition, the system takes into account the potential impact of future developments (such as international trade in TGCs and the interaction with Climate Change policy) it is necessary that :

- Subsidies are transparent and it is understood what happens to those subsidies when trade takes place
- The price of TGCs throughout Europe is transparent and easily available
- The Climate Change 'value' per TGC is understood
- Country transaction costs are transparent

If international trade is to take place, other factors will affect demand and hence the price of TGCs:

- Different obligations in different countries
- Cost of capital
- Planning regulations
- Grid connection regulations
- Price of physical electricity
- Differences in levels of 'indirect' support (such as national electricity trading systems which disadvantage intermittent sources, national systems which guarantee grid access for RE etc).

Thus, all price signals must be cost-reflective. As soon as new costs are introduced which are not reflected in the price of TGCs then incorrect price signals will lead to inconsistencies in the market. It is therefore questionable whether TGCs will be bought exactly in order of price. This makes it all the more important that buyers understand what they are getting when they buy a TGC.

5.4. Implications for the UK

5.4.1. Import/Export Balance of TGCs

If the UK were to participate in trans-national trading, because of its low renewable electricity prices and its good resource level, it should, in theory, be able to export cheap TGCs. The cheaper renewable energy technology companies should therefore expect an increase in their business. Moreover, a number of countries do not consider that the waste technologies fulfil their

definition of renewable electricity. In this situation, the UK would be expected to be a good market for on shore wind TGCs as the next cheapest technology.

There is a political risk attached to the sale of generation from wind power plants to other countries, depending on the definition of a GC, as discussed above. The UK could be open to criticism from anti-wind campaigners, who could hold that wind farm generation can neither be counted towards renewable energy targets nor towards the UK's CO_2 reduction targets. While the local benefits would be retained, this would reduce the overall benefit to the UK.

However, relatively little renewable electricity (except for landfill gas) has been commissioned in the UK over the last few years. With respect to wind energy, clearly much of this has been to do with problems with obtaining planning permission but there are other reasons as argued at length in another paper[18]. The RE Response paper has set out new measures to improve planning procedures for renewables. If wind energy continues to have problems obtaining planning permission then it would be expected that the UK will become a net importer of TGCs, provided the green credit included the CO_2 benefit. In this situation, the UK, will be buying in their CO_2 reduction without promoting wind energy in the UK and accruing the UK benefits with respect to jobs/services and local pollution reduction.

5.4.2. Implications for the UK of Staying Outside International Trading Systems

It is quite likely that a number of countries will standardise together to allow trade and set up some sort of 'Green Bubble'. If this happens, then the mechanisms that are put in place in the bubble can be expected to become the norm for trans-national TGC trading. If the UK stays outside such a system, it will continue to fulfil its policy without participating with other countries.

This:

- ensures that all extra benefits and costs of the UK renewables obligation and TGC system can be said to be feeding directly back to the UK;
- will allow a wider selection of technologies to be brought forward by the obligation;
- runs the risk that the UK will lose the competitive price advantage of renewable electricity gained through the NFFO if other countries evolve within new, large, competitive markets;
- is much easier to establish and administer.

5.4.3. UK Gains of International Trading

Despite the risks outlined above, the UK would benefit from participating in international trading provided that the UK obtains international credit (ie CO_2 emissions) for its TGC purchases. However, if this were not the case, then the benefits would appear to be outweighed by the dis-benefits.

The UK's gains would be :

[18] C.Mitchell, 1999, Annual Review of Energy

- access to a wider pool of renewable electricity to fulfil renewable energy obligation;
- access to cheaper generation from the technologies that are more expensive in the UK, (eg PV), which allows greater consumer choice;
- If the UK resource is cheaper (as expected for on- and offshore wind) it should be able to capture a bigger market (and therefore increase jobs/services in the UK and accrue local pollution benefits).
- If the UK resource is more expensive (as it will be for PV for example) then the UK will gain CO_2 credit against its commitments and customer choice at a lower cost.

If CO_2 credit were not linked to the purchase of green certificates but the renewable energy unit were allowed to be credited to the purchaser then the gains are:

- Access to a wider pool of renewable electricity to fulfil obligation
- Access to cheaper generation for more expensive technologies
- If the UK resource is cheaper it can attract more demand – it will lose its credit against renewable energy target but keeps the CO_2 credit
- If the UK resource is more expensive, then it can buy in renewable energy credit but not the CO_2 credit.

Table 3 (over) illustrates these points.

Table 3 : Implications of UK participation or non-participation in International trade in TGCs

	Bubble in some countries – no UK participation so the UK is meeting its targets from UK renewables	Bubble in some countries – UK participation.
Able to buy least cost electricity from bigger pool therefore cheaper to customers	✗	✓
Able to buy cheaper specialist renewables from bigger pool eg PV therefore cheaper and allows greater customer choice	✗	✓
Benefit from local greenness	✓	✓
Country of power plant production keeps international greenness (eg CO2) so customers of that country are not paying for something which then is credited to another country	✓	May lose greenness if UK renewables are cheaper; gain it if renewables are more expensive
Benefit from increased jobs/services from power plants which sell GCs	✓	Depends, will benefit if renewables are cheaper
Benefit from manufacture (if do so)	✓	Depends, will benefit if manufacture the technology
Retain country's competitive advantage	Depends, the UK is in theory cheap for some technologies. If reduce the scope of market may allow other countries to take that over.	Developers have access to wider market, may be able to retain competitive edge.

If neither CO_2 credit nor renewable energy deployment credit were linked to a TGC then there is no obvious point in trans-national trade in TGCs. The key point requiring clarity is the extent to which there is any logic in accepting that the renewable energy deployment credit is achieved with trans-national trade but that the credit does not include the unit of electricity's displaced emissions. From our perspective there is no logic to this – a GC represents the greenness of a renewable energy unit and all of this must be transferable to the purchaser and finally credited to the country of redemption.

However, there are a number of provisos:

1. In reality, it is questionable how much trans-national trade will occur simply because many suppliers may not wish to do so, preferring to support national companies. Thus, trans-national trade may become 'trade of last resort' if a supplier finds itself in difficulties.
2. It is not at all certain that the cheapest TGC will be bought first, then the next cheapest and so on because of subsidies (direct and indirect), national preferences, planning problems and so on. Therefore, it is not really known how the TGC prices will pan out and whether the UK will be an attractive market (as the theory appears to show)
3. The interaction between a low UK price-cap and trans-national trade is unclear. The price cap currently talked about by the UK Government (around 4.3p/kWh) for the UK obligation is a low price for European renewable electricity. This may indirectly promote trans-national sales from the UK.

In conclusion, there is no theoretical reason why there should be an economic difference to UK plc if the payment for a UK TGC (from an overseas buyer for the greenness) is equivalent to benefits realised through increased jobs and local benefits. Put the other way, if the cost of buying the TGC abroad is equal to the benefits of importing the greenness UK plc should be indifferent. In practice, it seems unlikely that the value of imported greenness will be equal to the value of jobs and local benefits. This is because the value of greenness will probably be related to the cost per tonne abated of CO_2. This valuation and its importance to the Government is, however, at the nub of the issue.

6. Conclusions

In this report we have described how Green Certificates (GCs) can be used to represent the 'greenness' of a unit of renewable electricity, allowing the unit to be divided into two parts so that the 'greenness' can be traded in isolation from the physical electricity.
We have set out the theory which proposes that Green Certificate systems can be used as an efficient way of allowing the market to meet ambitious targets for RE deployment and electricity production. We have described experience with GCs and TGCs across Europe so far and have examined the key issues which must be addressed in order to set up a TGC system.
In particular we have identified that further work is required on the interaction between RE and Climate Change policy and on the way in which international trade in TGCs might be realised.

6.1. Climate Change

RE policy interacts very closely with Climate Change Policy. There are therefore four potential uses for GCs (and TGCs) within the UK. These are :

1. GCs traded separately or combined with kWh which can be used against the RE obligation;
2. combined GCs & kWh used to obtain the CCL rebate for small business users, also eligible against the RE obligation;
3. combined GCs & kWh used to qualify for the Climate Change Levy (CCL) exemption for large business users, but not eligible against the RE obligation (not agreed as yet by Customs and Excise or DETR);
4. GCs traded separately or combined with kWh which are used within voluntary green power supply, which cannot be used against the RE obligation.

There are also key political questions relating to the way in which 'project' or 'JI'-type actions under the proposed Emissions Trading Scheme might interact with the RE sector in the UK (for example, will electricity from such UK Emissions Trading 'RE projects' be eligible for trading under the RE obligation? Or will this be double counting?).

6.2. International Trade

There are several key issues that must be resolved with respect to international trade in TGCs. The first, of course, is whether the UK wishes to establish a national TGC market where only UK-generated TGCs were valid or whether it wishes to become part of a wider trans-national market (for example, made up of EU countries) where TGCs from all EU countries are valid.

6.2.1. Key Issues

If trans-national trade is considered, a number of additional issues must then be resolved between parties to trans-national trades.
The most important of these are:

1. what is traded when a GC is bought?

2. which country receives the credit – for either or both reduced emissions and renewable energy deployment - the country of redemption or the country of generation?

6.2.2. Implications

Assuming that both emissions reduction and renewable deployment credit rests with the country of redemption, there are a number of implications for the UK remaining a national system, separate from trans-national trade:

- it ensures that all benefits and costs of the UK's renewable obligation and TGC system can be said to be feeding back directly to the UK;
- it allows a wider selection of technologies to be brought forward by the obligation;
- it is easier to establish and administer.

While more complex to establish, there are a number of implications of trans-national trade:

- UK suppliers would have access to a wider pool of renewable generation which would allow lowest cost fulfilment of obligation;
- if the UK resource (and TGCs) are cheaper in the short term (as expected) renewable companies should capture a bigger market (and accrue benefits of increased jobs and local pollution benefits);
- if the UK TGCs are more expensive, then the UK can buy in CO_2 credit more cheaply than from UK sources but at the expense of losing the benefits of developing the UK RE industry.

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