Tradable Certificates for Energy Efficiency: The Dawn of a New Trend in Energy Policy?

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ABSTRACT

Tradable green certificate (TGC) schemes have been developed and tested in several countries to foster market-driven penetration of renewable energy sources. Another well-known and widely analysed type of market–based instrument is the tradable CO_2 permit. The first international CO_2 emission trading scheme will soon start in the European Union (EU). Recently the attention of policy makers has been attracted by the possibility of introducing tradable certificates for energy savings (TCES) to stimulate energy efficiency investments and achieve national energy efficiency targets. TCES schemes have been recently introduced in Italy and the UK. However, there is a debate over the effectiveness and applicability of this instrument.

The paper describes the concept of a TCES scheme in the EU policy context. It discusses the main elements of a TCES scheme: the creation of the market and of the demand (eligible actions and technologies), the trading rules (validity of certificates, banking, borrowing), the possible cost-recovery mechanisms, and institutional infrastructure and processes to support the scheme (measurement and verification, penalty for non-compliance). The paper compares the TCES, a.k.a. white certificate, scheme with other similar policy tools such as an energy tax and mandatory demand-side management (DSM) programs on the following criteria: (a) certainty of outcome; (b) economic efficiency; (c) information requirements for the establishment and implementation; and (d) institutional costs. Finally, the paper discusses the possible integration with green certificates and CO_2 emissions trading schemes.

Introduction: The EU Policy Context

Under the Kyoto protocol, the European Union (EU) has agreed to reduce by 8 percent greenhouse gas (GHG) emissions between 2008 and 2012 relative to 1990 levels. As a result GHG issues are playing a central role in EU energy and environmental policies. At the same time the new priorities in the EU strategy for sustainable development, adopted by the Gothenburg European Council in June 2001, include the following targets regarding demand-side energy efficiency: realize the potential for energy-efficiency improvements as far as economically possible, and reduce energy consumption by 1 percent per year to achieve two-thirds of the potential savings (18 percent by 2010) and thereby reduce CO_2 emissions by about 40 percent of the EU's Kyoto commitment.

The other main EU energy policy drive is to restructure electricity and gas markets. A European Directive (96/92/EC) adopted in 1996 established rules for an Internal Electricity Market: EU member states were required to introduce wholesale and minimal retail competition (for customers who consume more than 40 GWh/year) by 1999. To accelerate electricity market restructuring, the European Commission proposed a new Directive in 2001. In June 2003 the new Directive on the market liberalisation was finally adopted (2003/54/EC) with the following timetable for market opening: the electricity and gas markets will be fully liberalised by July

2004 for non-household customers, and to all customers (including households) by 1 July 2007 at the latest. This process will take account of a report assessing the impact of liberalization to be presented by the Commission in 2006.

The EU Emission Trading Scheme

The second important policy area identified in the ECCP report was to introduce an EU emission trading scheme (EU ETS). Recently, the European Union adopted a Directive (2003/87/EC of 13 October 2003) introducing a scheme for greenhouse gas emission (GHG) allowance trading within the Community. The Directive allows emission trading (ET) in some sectors to start in 2005; the first three-year trading period will be limited only to CO_2.[1] In principle this scheme offers the possibility to implement the most cost-effective measures to reduce GHG emissions while still achieving the same environmental benefit.

Many argue that ET should incorporate energy-efficiency measures because these measures reduce CO_2 emissions by reducing energy use. One difficulty in including energy-efficiency measures in emissions trading is how to quantify the reduction in CO_2 emissions that results from an energy-efficiency measure, particularly for improvements in end-use efficiency.

For tradable permit systems in principle both so-called direct and indirect emissions approaches are possible. The direct approach is based on the physical source ('the pipe'), whereby the actual emitters are obliged to purchase sufficient emission permits.[2] The cost of the permits will be accounted for in the price of the products emitters sell: products with high carbon content will become more expensive and buyers will respond by consuming less or switching to an alternative with less price rise (which presumably, but *not certainly,* is also less carbon intensive). Hence, this approach only indirectly gives some incitement to energy savings as a means to consume less carbon intensive product without loosing the desired service level. Furthermore, cost differences between product alternatives are not only caused by carbon intensity. Conversely, the indirect approach is based on the idea that the final users, who are causing the whole production chain, should see more precisely what the carbon intensity is, as get allotted emission quota based on a baseline energy.

The EU ETS follows the direct system, among other things because of the monitoring and inspection complications inherent to the indirect scheme, especially at an international scale. This makes the guidance of energy efficiency for companies inside the ETS only indirect.[3] Furthermore, sectors outside the ETS are influenced by the so-called initial division of reduction tasks between trading and non-trading sectors. If member states wish to favour the export-

[1] The scheme is supposed to cover about 46 % of the EU-15's total CO_2 emissions in 2010 and involve about 5,000 installations that fall under the activities specified in Annex I: practically all energy intensive sectors (apart from the Chemical sector). Each installation gets emissions allowances for the whole period. For the first period (2005-2007) installations are free of charge (grandfathering), for the second phase (2008-2012) up to 10% can be auctioned. The Member States have to allocate the emissions to the concerned installations by means of a national allocation plan (NAP) and according to defined criteria. The plans will be checked then by the European Commission. If installations do not meet their obligations they have to pay a penalty of 40 Euro per ton CO_2 for the period 2005-2007, for the next periods it will be 100 Euro per ton CO_2. Emission reductions from joint implementation (JI) or clean development mechanism (CDM) projects can be used by the companies to fulfill their emission reduction targets. The details will be regulated in a specific Directive, which has been proposed by the European Commission during 2003. It is also agreed that companies have the possibility to pool their emissions allocations until 2012, which means that e.g. industrial branches can try to find a common solution.
[2] What 'sufficient' exactly constitutes depends on the kind of quota allocation and trading system chosen.
[3] Even though there are references to BAT procedures in the Directive coming from the IPPC Directive.

oriented companies inside the EU ETS, they end up with having to demand more efforts from other sectors in order to fulfill the overall target. Energy saving is a rather important option for those non-trading sectors. However, for electricity saving this is less the case since the benefit of less emissions remains with the power generation sector.

Under these circumstances one may wish to seek additional means to get more energy saving realized. Rather than imposing sector specific efficiency obligations one could choose to introduce a tradable electricity saving certificates in conjunction with electricity saving quota. The same logic applies here as in the emission permit trade. Instead of realizing the whole electricity saving in the own company/sector, one may look for sectors and companies where this can be achieved at lower unit cost. If the overall amounts and the reduction in unit cost of saved MWh are sufficiently large compared to the – likely – extra transaction cost of the tradable white certificate system, the white certificate system is worth trying.

European Tradable Green Certificate Schemes for Electricity from Renewable Sources

The Renewable Electricity Directive

The EU adopted a Directive in 2001 (2001/77/EC) to increase the share of green electricity from 14 to 22 percent of gross electricity consumption by 2010. It establishes non-mandatory national targets[4] for the portion of electricity consumption to be met by RES. To achieve these targets, the directive foresees continuation of national support schemes plus, if necessary, the creation of harmonized market-based support system compatible with the rules of the internal EU electricity market.

Tradable Green Certificates

During the past few years, interest in tradable certificates has increased markedly in Europe and elsewhere, and markets have been established in a number of EU member states, including the UK, the Netherlands, Italy, Belgium (Flanders), Sweden, and Austria. In principle, TGC schemes work as follows: a quantified obligation (quota) is imposed on one category of electricity system "operators" (generators, producers, wholesalers, retailers, or consumers) to supply or consume a certain percentage of electricity from renewable energy sources (RES). On a settlement date, the operators must submit the required number of certificates to demonstrate compliance. Certificates can be obtained in one of the following ways. First, operators can own their own RE generation, and each defined amount of energy (e.g. each 100 KWh) produced by these would represent a certificate. Second, operators can purchase electricity and associated certificates from eligible RES-E generators. Third, operators can purchase certificates without purchasing the actual power from a generator or trader or via a broker, i.e. certificates that are traded independent from the power itself.[5] Because of supply-side competition, a TGC system

[4] The European Commission will monitor the progress of individual member states toward their national objective and will, if necessary, propose mandatory targets for member states that do not reach their goals.

[5] In a TGC scheme, each certificate is unique and associated with a defined and identified amount of electricity produced from renewable sources (e.g., 1 MWh of wind energy produced on date and time XY by generator ZZ). The purchase of a certificate without the purchase of the associated power would in any case transfer the ownership of the "greenness" of the renewable electricity produced from the original power producer to the new market actor

leads, under perfect market conditions (perfect price signals), to minimal generation costs for renewable energy sources, but only if there is surplus renewable generation beyond the demand for certificates.

Tradable Certificate Schemes for Energy Savings

With the gradual opening of European electricity and gas markets to competition, new policy tools that are compatible with market conditions are needed to promote energy efficiency in end-use. A possible market-based policy portfolio could comprise energy-savings quota for some category of operators (distributors, consumers, etc.) coupled with a trading system for energy-efficiency measures resulting in energy savings. The savings would be verified and certified by the so-called "white" certificates.

Common issues raised by TCES schemes already under way are: setting the policy goal (electricity and/or gas savings, primary energy savings, carbon savings, etc.); setting the obligations to create the demand for certificates; defining the annual energy savings targets; defining which market actors (e.g. electricity/gas distributors or suppliers, end-users, etc.) would be subject to the obligation(s); apportioning the target into individual obligations; setting any specific requirements to meet the obligation and the rules for issuing of the certificates; establishing who can certify the savings, issue the certificates, and redeem them; ascertaining who can get certificates and who must hold the certificates at the end of the periods; defining what types of technologies and projects are eligible, what the redemption period should be, and how to arrange banking and borrowing, etc. Finally, defining a non-compliance regime (i.e. the technical ability to detect non-compliance and the legal ability to sanction it), and the trading rules (certificates exchange and/or bilateral contracts) are issues to be carefully considered.

Attention shall be paid to the overall goal of the TCES scheme. If the aim of the scheme is to save primary energy, to increase security of supply, or to mitigate climate change, this can be achieved in end-uses through (a) additional investments in energy efficiency projects (which may not always result in energy savings), (b) change in behaviour (e.g. switching off the lights), or (c) change in conditions (e.g. indoor temperature, production levels, occupancy levels). The overall policy aim then defines the eligibility rules for the TCES scheme. If the scheme aims at stimulating additional investment in energy efficiency, eligible saving are the ones resulting by investments in energy efficiency evaluated at the same system conditions. Another important consideration is whether to allow the trading of the 'savings' (as certified by the certificates), or to allow also the trading of the obligations. The setting of sanctions for non-compliance with the energy efficiency obligation will have to be "*proportional and in any case greater than investments needed to compensate the non-compliance*" (Malaman & Pavan 2002), as is in the Italian system, to ensure that the operators try to achieve the targets. The relation between the overall target, the individual targets, and the cost-effective energy saving potential available has to be carefully analyzed.

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and therefore would prevent the original power producer from claiming that they have ownership of the amount of "green" energy that the certificate represents. The owner of the certificate can then dispose of it to meet its obligations or to get tax incentives that authorities may pay to power producers for development of additional RES generation capacity. Therefore, purchase of a certificate even without the associated power contributes to the development of RES capacity.

Verification: Concerns and Methods

One of the main implementation issues for TCES schemes is choosing a verification system for energy-efficiency projects (using standard values for energy saved by particular measures versus directly measuring savings) and setting baselines ("business-as-usual" scenarios) to measure the impact of projects.

Verification Concerns

The basic function of the certificate is to certify that a certain amount of energy is saved compared to a reference scenario. The choice of the reference scenario offers some difficulties. It has some common issues with policy instrument such as JIs and CDMs in climate change mitigation. The Executive Board of the Kyoto Protocol's Clean Development Mechanism has recently approved the first two baseline and monitoring methodologies, thus giving a major boost to the CDM. Baseline and monitoring methodologies play a key role in determining how well the CDM functions as they help ensure that emission reduction credits claimed by CDM projects are legitimate. The same holds true for TCES schemes.

The saved energy resulting from an energy efficiency measure could be measured at the end of a predetermined period (e.g. after 1 year) or over the lifetime of the project (which has to be accurately assessed). The certificate can be equal to the energy saved over the period or the lifetime of the project, or could be issued when a certain amount of energy savings has been achieved (e.g. 1 MWh). The latter option will make the system simpler and more comparable to a TGC scheme: the certificate will have a unique time of issue attached to it, will indicate the period over which and the location where energy has been saved, and by whom it has been saved (initial owner of the certificate). It is essential that each certificate is unique, traceable, and at any time has a single owner. This very important notion is missing in some of the early energy efficiency certificate schemes where the whole potential energy savings of an energy efficiency action is assumed a priori and an equivalent certificate is issued.[6]

The validity and the ownership transfer rules of the certificate will be set by the trading rules. Banking or borrowing may be allowed; this does not modify the value of the certificate, i.e. that a measured amount of energy has been saved, during a specific time, and in a specific location as a result of an energy efficiency action. As discussed later, reference consumption and conditions need to be allocated to each participant in the scheme under obligation. This is the major difference with the TGC scheme where electricity production can be measured without any reference, even if only additional generation capacity is allowed in the scheme for a limited amount of time: at each additional supply point one can add a meter and check the electricity production after or during a specified period.

If the electricity savings cannot be metered then more problems appear, as an estimation of the energy saving for a specific measure must be carried out. For instance, the saving from the replacement of an old refrigerator with one in class A+ are calculated on the difference with the installed average or the sales average (we have already a first approximation, one which could be underestimating or overestimating the energy savings). The savings XY kWh per year can be calculated and each time the basic unit of the certificate is reached the equivalent

[6] This poses a risk of overestimation of savings e.g. if the equipment fails to perform in accordance with the initial assumption. At the same time it increases investment security: the amount of certified savings is clear from the start.

certificate will be issued. If after a certain period the appliance is changed or fails, the issuing of certificates linked to that appliance should stop.

Another important aspect is whether to certify saving measures, which do not include energy efficiency improvements but behavioural changes or other structural changes, e.g. the user may decide to switch off equipment, decrease the set point (heating/cooling) or the size of equipment. This may conflict with structural or temporal changes forced on the participants by other circumstances: for instance, a contraction of business (e.g. an empty hotel) or a smaller production output will result in energy savings. Allowing the certification of these may penalise companies, which are in a business expansion phase that leads to more consumption. The scheme may adjust ex-post the certificates for climatic condition and/or production levels.

Verification Methods

Verification of the savings to be achieved is a key challenge in white certificate schemes. Possible approaches are:

- *The Metering Approach* – metering real electricity consumption and calculating savings (could be with climate or whether corrections) based on consumption before and after the energy-efficiency improvement is carried out, or
- *The Standard Savings Formula Approach* – using standard formulas for energy-efficiency measures (e.g., a given number of CFLs installed is the residential sector is equivalent to a given number of kWh saved; the formula can be adjusted to reflect if the CFL are installed or if there is an incentives to buy them for end-users).

Although the metering approach would be a more accurate guarantee of energy saved than the standard factors approach (the latter cannot verify details such as location and operating hours of installed CFLs), it may result in too high measurement costs. One solution would be to use the metering approach and to take into account the conditions prevailing in the facility, which would affect the energy efficiency project. Before being granted a certificate, operators could be required to describe the measures they are implementing and provide metered data before and after the implementation, as well as any "standard" information and conditions (weather, activity, etc.) needed to evaluate the measures (e.g. their load profile).

One of the frequently used protocols to verify energy savings is the International Performance Measurement and Verification Protocol (IPMVP) (www.ipmvp.org). IPMVP provides an overview of current best practice techniques available for verifying results of energy efficiency projects in commercial and industrial facilities. It may also be used by facility operators to assess and improve facility performance. Energy conservation measures covered in the protocol include fuel saving measures, water efficiency measures, load shifting and energy reductions through installation or retrofit of equipment, and/or modification of operating procedures. In 2001, a revised addition of the IPMVP was issued. It builds on the excellent history and working knowledge gained from previous editions.

National Implementations

Recently, an innovative policy mix has been introduced in Italy, which combines command-and-control measures (energy-savings targets for electricity and gas distributors) with market instruments (tradable energy-efficiency certificates issued both to distributors and energy service companies), as well as with elements of tariff regulation (cost recovery mechanism via electricity and gas tariffs and multiple driver tariff schemes to avoid profit losses) or dedicated funds in some circumstances. The Italian scheme finally became operational in January 2004; the first check on the compliance with the obligations will be accrued in mid-2005. Currently it is not integrated with the RES TGC in force in Italy.

In Italy two national Decrees set mandatory national energy savings targets for the period 2002-2006 (Malaman & Pavan 2002). The targets are set in terms of savings in primary energy consumption. At least half of the target set for each single year will have to be achieved via a reduction of electricity and gas end-uses (referred to as the "50% constraint" to which each distributor is subject). The remaining share can be achieved via primary energy savings in other sectors. Each year national targets are apportioned among distributors that serve more than 100,000 customers on the basis of the quantity of electricity and gas distributed to final customers compared to the national total in the previous year. The targets do not refer to specific end-use sectors and/or types of projects. A list of eligible projects is attached to both decrees, but this is *illustrative* and therefore 'open'. To count against the obligation, energy savings projects will have to be implemented by distributors (directly or via controlled companies), or by "independent companies operating in the energy services sector" (i.e. ESCOs). The maximum lifetime of each eligible project is conventionally set at 5 years as far as its contribution to the fulfillment of the mandatory targets is concerned. The Italian TCES scheme uses three valuation approaches: (a) a deemed savings approach; (b) an engineering approach; (c) a third approach based on monitoring plans[7] whereby energy savings are inferred through the measurement of energy use.

In the UK, the Energy Efficiency Commitment (EEC) program requires that all energy suppliers with 15,000 or more domestic customers must encourage or assist those customers to take energy-efficiency measures in their homes.[8] Suppliers may trade among themselves either energy savings from approved measures *or* obligations, with written agreement from the regulatory office (Ofgem). At present there has been little interest in trading. This reflects two developments: that energy savings can *only be traded once the supplier energy saving target has been achieved* and that the suppliers are expecting a successor mechanism to follow from 2005.[9] Suppliers are allowed to trade excess energy savings into the national emissions trading scheme as carbon savings (Costyn 2002).[10]

Recently other EU Member States have announced their intention to introduce a TCES scheme; among these are France and possibly Sweden. TCES schemes will attract more and more the interest of national policy makers, as the proposal for a Directive on Energy End-Use Efficiency and Energy Services (COM(2003) 739 final), recently adopted by the European Commissions, says in Art. 4 "the Commission will examine whether it is appropriate to come forward with a proposal for a Directive to develop further the market approach in energy efficiency by means of "white certificates"." The proposal gives a clear definition of white

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[7] The plans must be submitted for pre-approval to the regulatory authority AEEG and must conform with pre-determined criteria (e.g. sample size, criteria to choose the measurement technology, etc.)

[8] The only constraint on suppliers' activity is that they must achieve at least half of their energy savings in households on income-related benefits and tax credits.

[9] We are indebted for this insight to Charles Hargreaves.

[10] The rules will be devised by the UK Department of Environment and OFGEM, when the ET policy is finalized.

certificates as “certificates issued by independent certifying bodies confirming the claims of market actors for savings of energy, as a consequence of energy end- use efficiency measures”.

Comparative Analysis

Below we discuss briefly how a TCES scheme compares with an energy tax and mandatory DSM programs in important aspects such as certainty of outcome, economic efficiency, information requirements for establishment and implementation, and institutional costs.

Certainty of Outcome

The mandatory target of a TCES scheme keeps the advantage of certainty of outcome, while the certificate trading gives the flexibility for cost-efficient compliance; thus the market forces determine the allocation of activities, but not the scale of action. This feature however can be undermined by ambiguities in reference consumption and conditions, M&V procedures, and “additionality” issues. The outcome of mandatory DSM may not necessarily include quantified mandatory targets on energy savings; DSM becomes hard to implement with unbundling and retail competition in the energy sector. An energy tax is usually not linked to a savings target; rates are often set according to the fiscal requirements, not according to a valuation of externalities[11] or a desired environmental target.[12] One way towards certainty of outcome is to combine mandatory DSM and taxation in the form of a public benefit charge (PBC).

Economic Efficiency

The most straightforward mechanism to optimize energy efficiency in economic terms is to fully internalize externalities in the price via a Pigouvian tax. In theory tradable certificates have the same economic efficiency as taxes; essentially the two differ in the path towards efficiency. The way to equilibrium for a tax is that a public agency – not the market – sets a charge that may cause excess demand or supply (Faure & Skogh 2003). Mandating certain quantity of savings in a TCES scheme results in a price emerging for the certificates that represent savings as a commodity. In theory, by allowing trading among participants the scheme provides a uniform cost signal – the certificate trading price – to *all participants* and thus applies the equi-marginal principle for cost-minimization (Jaccard & Mao 2002).[13] Cost minimization (*i.e.* static efficiency) depends on the liquidity of both the buyer and seller markets. While cost minimization is embedded, the exact cost of achieving the pre-defined outcome of such a scheme is not known in advance. A TCES scheme also encourages market participants (ESCOs or manufacturers) not covered by the quotas to invest in energy efficiency projects and sell the associated certificates to the operators with quotas.

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[11] Due to the huge number of activities involved and persons affected, and difficulties in quantifying many important consequences, externalities are problematical to evaluate (Andersen 2000).

[12] Baumol and Oates (1988) suggest setting a charge/tax to achieve specific pre-define standard/target rather than attempting to base the tax on the unknown value of marginal net benefits. Consequently the rate may need to be adjusted to generate an iterative path converging towards the pre-defined target. This procedure that may turn out to be politically unacceptable.

[13] What the impact on non-participants would be is an issue that needs to be carefully analyzed.

An energy tax charges a price for pollution and gives a uniform cost signal throughout the economy, which theoretically results in demand reduction of the polluting activity. Common practices such as tax differentiation and exemptions undermine the cost efficiency by disregarding opportunities for compliance at the same marginal cost (Andersen 2000).[14] The mandatory DSM does not allow the regulator to receive information regarding the optimality over time. If cost recovery is allowed, the regulator may exclude high cost-low impact programs via e.g. lump sum cost recovery to reflect standard allowed costs related to specific activities.

Information Requirements

Under certainty about the relevant marginal control/compliance costs and marginal benefit functions, exactly the same result can be achieved by marketable permits and taxation: if the regulator issues the *optimal* number of permits, then the price bid in the market will be precisely the level of a Pigouvian tax (Baumal & Oates 1988).[15] In the real world, where information is limited, the benefit of trading is that it reallocates certificates to their highest value without the need for central information about the shape of the marginal net benefit curves (Faure & Skogh 2003). However, significant information requirements are involved in e.g. target apportionment[16], baseline setting, choice of reference technology and conditions, M&V, and non-compliance detection. The main information requirement related to taxation is setting the tax rate: ideally it should be equal to the marginal net damage produced by e.g. electricity generation.[17] Similar difficulty plagues the calculation of an optimal rate of a lump sum cost recovery, which should be equal to the marginal net benefit of an activity.

Institutional Costs

Institutional costs are often cited as the main disadvantage of certificate trading schemes: they involve costs to monitor, verify, register, certify, trade and acquit certificates, which are likely to be substantial, especially at the early stage of designing and initiating the scheme. Factors influencing the administrative burden include the number of regulated sources, the availability of the necessary data, the level of reporting and monitoring needed. Since cost recovery can be part of mandatory DSM program, institutional supervision and the associated institutional costs for the utilization of these funds is needed in both cases. Other policies, e.g. tax exemptions, also impose institutional transaction costs. Apart from institutional costs, search costs and elements of strategic behavior may impede transfers between obliged parties in a TCES scheme. To date, hardly any comprehensive attempt has been made to list and quantify the

[14] The effectiveness and efficiency of economic instruments, such as tradable certificates and taxation, are dependent upon elasticities that operate on behavior (in relation to price, substitution, and income), on the strength of the signal given (e.g. the level of the tax), and on the availability of substitution or alternative actions (Hogg 2000).

[15] A tax will be preferred on welfare maximization grounds if the marginal control cost curve is steeper than the marginal benefits curve; the opposite is valid for marketable permits (see Baumol&Oates 1988).

[16] Which ideally should require calculation involving simultaneous relationships and extensive information on each obliged party marginal cost function (Baumol&Oates 1988).

[17] This method, as Andersen (2000) notes, is complicated by the absence of information on relevant elasticities. Baumol and Oates (1988) point the huge information requirements of calculating the optimal tax level of an externality-generating activity, since it should not equal to the marginal net damage it generates *initially,* but to the damage it would cause if the level of the activity had been adjusted to its *optimal level*.

parameters affecting institutional costs, and to conduct a comprehensive analysis and comparison of institutional costs of different policy tools (Boom & Nentjes 2002).

Interaction with Other Schemes

Interactions of policy instruments may arise from overlaps in objectives, target groups, or the design and implementation rules. Integrating a market for TCES with ET or with a market for TGC would establish one homogenous good and avoid the creation of parallel markets, which would impose higher transaction costs and/or sub-optimal market size for one of these (Langniss & Praetorius 2003). Too many separate schemes and markets can be confusing and at the advantage of large actors who are in a position to play on more than one market.

Integration of a domestic TCES scheme with ET will increase compliance options, reduce compliance costs, increase liquidity of the ET market, and stimulate energy efficiency projects and the development of ESCOs.[18] The ability to do domestic projects that generate allowances may act as a "safety valve" for buyers in an ETS scheme by not limiting source of allowances to only those with surplus under their allocations (Langniss & Praetorius 2003). However, linking requires robust tracking and data management across markets. For instance, to avoid double counting, white certificates, i.e. project credits*,* should be submitted to the governmental body of the respective country that will have to subsequently exchange it for allowances. Difficulties with deciding upon an "exchange rate" may emerge, especially on international scale, since the carbon value of energy savings varies significantly across countries. A possible consequence of imposing energy saving quotas without linking the schemes may be that the cheapest options on the demand side are "stolen" and go to white certification; this may limit the scope of CO_2 abatement options and increase the price of tradable carbon allowances.

It is possible to combine a TGC and TCES in a common scheme, where both RES and end-use energy efficiency measures could be bid in real time through the Internet to meet a specific obligation.[19] Energy savings may contribute to meeting an overall RES target by reducing the overall consumption. The common element of green and white certificates is that both allow for the separation of the physical flow of electricity from, respectively, the "greenness" of electricity and the energy savings. From cost efficiency perspective, integration of supply and demand options should result in the lowest cost for society. Conversely applying different instruments to different parts of the sector increases the risk of undertaking high-cost measures at one part, while ignoring lower cost options in the other. Purely operational matters, like registries, can be managed in an integrated way. Nevertheless, integration must be approached with caution since energy efficiency certificate trading is more challenging than TGC trading especially in terms of measuring and verifying savings. Double counting threatens this integration too: e.g. how to treat a project, such as CHP on biomass that may receive emission allowances, and be eligible for green and white certificates.

[18] This is not possible in the EU ETS, which allocates the emission allowance only to some industrial sector and to power producers. However, when an end-user reduces its electricity consumption, CO_2 emissions of the power producer is reduced. The end-use certificate scheme could be used to transfer part of the benefits that the power producers receive by lowering its CO_2 emission to the actor who has actually saved energy.

[19] The Australian TGC scheme for electricity from RES allows certification for solar water heaters based on the electricity consumption they displace (Andrews 2001).

TCES can be a mechanism to quantify and endorse savings in an official and formal way for different energy policies such as tax credits, incentives, special tariffs. Double counting can be avoided by using a database and again in the principle of redemption.

Conclusions

In theory TCES scheme could deliver cost efficient energy savings in a liberalized electricity and gas market. Key issues to carefully consider include defining the policy goal under which to implement this policy tool (climate change mitigation, security of supply, development of technologies, etc.), setting the obligations, determining the obliged parties, the verification rules, the trading rules, and the under- or non-compliance regime.

The most commonly cited benefit of certificate trading – minimization of costs of compliance – depends on the liquidity of the market. There is a certain trade-off between liquidity (e.g. allowing non-obliged parties to acquire and sell certificates) and manageability and transaction costs of the scheme. The latter may be very high and a simple obligation on energy savings for electricity and gas distributors may turn out to be a better way to deliver the desired outcome. As the first 'real' TCES scheme is to start in Italy, it is still to be seen whether this policy instrument will deliver savings and at what cost this will be achieved.

TCES have many common features with TGC schemes for electricity from renewable sources. The existing TCES schemes are not integrated with TGC schemes; such integration requires careful consideration and setting of common obligations among other because, as has been discussed in this paper, energy-savings certificate schemes are more complicated than TGC schemes. In parallel the further development and testing of TCES schemes are needed to prove the effectiveness and cost-efficiency of this instrument.

Both TCES and TGC schemes could be also linked to emission trading, as both schemes may results in CO_2 emissions reduction, and these can be calculated. The carbon value could in principle be calculated and included in the certificate (even in a more sophisticated way than national or EU averages). Both the electricity (or energy) savings and the carbon savings may be verified and used to prove compliance with some obligations. A possible advantage of combined schemes is that once one of the two values is redeemed (the energy or the carbon) the certificate would be declared non-valid, *i.e.* this would avoid double counting. What is important is the traceably of each certificate (date and place of issue, and current ownership). The same certificate could be used also for other policy instruments such as incentives, special tariffs, taxation, etc.; in this case the double counting could be avoided again through the use of the database and the principle of redemption.

References

Andersen, M. S. 2000. "Designing and introducing green taxes: institutional dimensions." In *Market-based instruments for environmental management. Politics and Institutions.* Andersen, M.S. and Sprenger, R.-U. (ed.). Cheltenham: Edward Elgar.

Andrews, G. 2001. "Market Based Instruments: Australia Experience With Trading Renewable Energy Certificates." In *Proceedings of the UNFCCC workshop on Good Practices in Policies and Measures*. Copenhagen.

Baumol, W. J., and W.E. Oates. 1988. *The Theory of Environmental Policy*. 2nd edition. Cambridge: Cambridge University Press.

Boom, J.-T. and A. Nentjes. 2002. "Alternative design options for emission trading: a survey and assessment of the literature." In *CATEP workshop on the Design and Integration of National Tradable Permit Schemes for Environmental Protection.* Dublin: Environmental Studies, University College Dublin.

Costyn, J. 2002. Certificate Trading for UK's Energy Efficiency Commitment. *Paper presented at IEA/CESI workshop on Energy Efficiency Certificate Trading*. Milan, Italy: CESI.

Faure, M. and G. Skogh. 2003. *The economic analysis of environmental policy and law. An introduction.* Cheltenham: Edward Elgar.

Hogg, D. 2000. "The limitations of economic instruments as stimuli for technical change, technological change and innovation." In *Market-based instruments for environmental management. Politics and Institutions.* Andersen, M.S. and R.-U. Sprenger (ed.). Cheltenham: Edward Elgar.

Jaccard, M. and Y. Mao, 2002. "Making Markets Work Better." In *Energy for sustainable development.* Johansson, T. and J. Goldemberg (ed.). New York: UNDP.

The International Performance Measurement and Verification Protocol (IPMVP) 2001. Available also at: http://www.ipmvp.org

Langniss, O. and B. Praetorius. 2003. "How much market do market-based instruments create? An analysis for the case of "white" certificates." In *Proceedings of the European Council for Energy Efficient Economy (ECEEE) summer study.*

Malaman R. and M. Pavan. 2002. "Market-based policy approaches for end-use energy efficiency promotion." In *Proceedings of the IEECB'02 Conference*. Nice: ADEME.