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Tradable white certificate schemes: fundamental concepts

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Abstract A number of European countries have introduced market-based instruments to encourage investment in energy efficiency improvement and achieve national energy savings targets. Some of these schemes are based on quantified energy savings obligations imposed on energy distributors or suppliers, coupled with a certification of the energy savings (via white certificates), and a possibility to trade certificates. The paper describes the concept and the main elements of a tradable white certificate scheme, where appropriate giving examples from existing schemes in Europe. It discusses design and operational features that are key to achieve the overall savings targets, such as delineation of the scheme in terms of obliged parties, eligible projects and technologies, institutional structure, and processes to support the scheme, such as measurement and verification. Finally, the paper looks at a number of open issues, most importantly the possibility of creating a voluntary market for white certificates via integration into the carbon market.

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Introduction

Energy efficiency is a sound part of the environmental and climate change agenda and contributes to meeting the goals of improved security of energy supply, economic efficiency, and increased business competitiveness coupled with job creation and improved consumers' welfare. The Green Paper on Energy Efficiency states that by 2020 the European Union (EU) could save at least 20% of its energy consumption in a cost-effective manner (European Commission 2005) and lists a number of options to achieve this. The Directive on Energy End-Use Efficiency and Energy Services (2006/32/EC) aims at fostering cost-effective improvement of energy end-use efficiency and at transforming and promoting the market for energy services. The directive sets forth an indicative energy savings target of additional 9% by 2016; the baseline for the energy savings target is calculated using the average energy consumption during the 5 years prior to its adoption. The directive stipulates that the Commission shall examine whether it is appropriate to come forward with a proposal for a directive to further develop the market approach in energy efficiency improvement by means of white certificates.

The other main direction in EU energy policy is the restructuring of electricity and gas markets. Directive 2003/54/EC on market liberalization made it possible for all customers to choose their supplier starting from 1 July 2007. The effects of liberalization on energy efficiency are versatile: falling prices give rise to short-term approaches from suppliers focused on maximizing turnover and may make suppliers hostile to action beyond the consumer's meter. At the same time, improved efficiency at the demand side may be fostered by suppliers trying to retain consumers and attract new ones by offering energy services as "added value" to the offer of an otherwise homogenous commodity such as electricity. A key policy challenge is to establish long-term synergies between the energy sector liberalization and end-use energy efficiency. A possible market-based policy portfolio oriented towards end-use energy efficiency could comprise energy savings quota (obligations) for some categories of energy market operators (distributors, suppliers, consumers, etc.) coupled with a trading system for energy efficiency measures resulting in energy savings. The savings would be verified by the regulator (or the national authority charged with this role) and certified by means of the "white" certificates (certificates for energy savings). Other parties that are not subject to an energy savings quota can also be allowed to certify the energy savings from eligible projects implemented and sell the white certificates, thus generating an additional stream of revenue for themselves, increasing the certificate market liquidity, and allowing the operators under obligation to reach their obligations at lower cost. In this way, tradable white certificates allow greater flexibility and the implementation of the most cost-effective measures, thus potentially—at least in theory and assuming perfect markets—minimizing the overall costs of compliance for obliged parties[1]. A comprehensive discussion on the cost-effectiveness and environmental effectiveness of this policy instrument, compared to other energy efficiency policy instruments, is available in Bertoldi and Rezessy (2006).

A white certificate is both *an accounting tool*, which proves that a certain amount of energy has been saved in a specific place and time, and a *tradable commodity*, which belongs initially to the subject that has induced the savings (implemented a project) or owns the rights to these savings and then can be traded according to the market rules, always keeping one owner at the time (Bertoldi and Rezessy 2006; Capozza et al. 2006; Oikonomou et al. 2007).

It should be emphasized here that improving energy efficiency and energy savings are two separate concepts, which can exist independently and may be targeted separately by policy intervention. Increased energy efficiency of a system does not always result in energy savings because of factors such as the "rebound effect"[2] of partially offsetting efficiency improvements with greater usage or improved comfort and because of the reduced unit cost of energy services, which also fuels consumption. On the other hand, energy savings may be disconnected from energy efficiency improvements and result from, e.g., behavioral changes (such as turning off equipment when not in use) or changes in system conditions (such as reduced indoor temperature and lower production or occupancy levels). Often the term energy conservation is used to denote energy savings, which do not result in improvements to energy efficiency. In the authors' view, only *additional energy savings* justify a policy intervention: policy may support measures that involve either investments or achieved savings (or both) provided that they are

[1] This does not necessarily imply minimization of total costs of energy-saving measures for society as a whole.

[2] Empirical works show 20–30% rebound effect for space heating in residential building retrofits in Austria (Haas and Biermayr 2000); in the UK, Milne and Boardman (2000) found that about 30% of the potential energy savings from retrofit measures was taken as increased comfort in low-income households as of the late 1990s. Other empirical studies found rebound effect in US manufacturing of 24% (Bentzen 2004) and rebound effect for all Organization for Economic Cooperation and Development energy use of 5–15% (Schipper and Grubb 2000, cited in Binswanger 2001, and Oikonomou et al. 2004, respectively). But the magnitude of this rebound effect is declining over time due to the increasing penetration of central heating and increasing average indoor temperature (Geller and Atalli 2005). The sizes of the rebound effect differ markedly across technologies and measures: for example, for refrigerators, there has been a mere 1.7% increase in adjusted net volumes of refrigerators over the period 1994–2004 (Meli 2005). For an extended discussion of the rebound effect, see, for instance, the special issue of *Energy Policy* from June 2000 (Volume 28, Issues 6–7).

measured against the same system conditions. Measures may include:

- Investments in energy efficiency evaluated against the same system conditions (i.e., "hard" measures such as equipment upgrade or installation) as well as
- "Soft" measures (information, good management, and education on behavior changes, such as switching off equipment when not in use).

The present paper updates earlier work of the authors (Bertoldi and Rezessy 2006). It provides an extended discussion of the general characteristics of white certificate schemes, where necessary illustrating the discussion with examples, and serves to give the reader a general picture of what white certificate schemes are, preparing the reader to the specific topics covered in the papers to follow. Beyond the EuroWhiteCert project that forms the basis of the present special issue, a number of concerted research actions have focused on white certificates in Europe, including the White and Green project[3] and task XIV of the International Energy Agency Demand-Side Management Implementing Agreement[4], as well as individual research activities (Sorrell 2003; NERA Economic Consulting 2006; Oikonomou et al. 2007).

The "Tradable white certificate schemes: fundamental concepts" section of the present paper introduces the fundamental design concepts of a policy portfolio with tradable certificate for energy savings (tradable white certificates, TWCs). It looks at the implications of different design choices of the main elements of a TWC scheme, also providing some practical examples from the three operational schemes in Europe. While details and evaluation of the national schemes are available in other papers in this special issue, concrete examples about the design choices of schemes in Europe serve the present paper to demonstrate that, while these schemes are conceptually similar, the implementation shows some marked differences. The section "Open issues and possible directions for development" raises a few open issues that have so far stayed outside of mainstream discussions on TWCs. The section "Summary and conclusions: what has (not) worked" concludes with a few general observations about design issues and some country-specific remarks on what has worked in different contexts.

[3] www.iiiee.lu.se/QuickPlace/whiteandgreen/Main.nsf/h_Toc/695a3dfe0be56ce1c1256eba00356cb1/!OpenDocument

[4] http://dsm.iea.org/

Tradable white certificate schemes: fundamental concepts

In principle, a portfolio with tradable certificate for energy savings (also known as tradable white certificates) involves five key elements (Pavan 2002, 2003; Langniss and Praetorius 2003; Bertoldi et al. 2005; Bertoldi and Rezessy 2006):

- Creation and framing of the demand;
- Tradable instrument (certificate) and the rules for trading;
- Processes to support the scheme and the market (measurement and verification, evaluation methods, and rules for issuing certificates, a data management and certificate tracking system and a registry);
- Cost recovery mechanism in some cases, and
- Enforcement mechanisms and sanctions.

Similar policy portfolios have been introduced in Italy, Great Britain, and France. In the Flemish region of Belgium, there are savings obligations imposed on electricity distributors without any trading option. Other European countries, such as Denmark, the Netherlands, and most recently Poland, have expressed interest in introducing white certificate schemes. Poland intends to introduce a white certificate scheme from 2009. The first scheme in the world with a white certificate trading element has been introduced in New South Wales (Australia; see paper in the present special issue). It is however a greenhouse gas (GHG) trading system that has an end-use energy efficiency element.

The European Directive on Energy End-Use Efficiency and Energy Services defines white certificates as follows: "certificates issued by independent certifying bodies confirming the energy savings claims of market actors as a consequence of energy efficiency improvement measures."

Creating demand

There are two options to create demand for tradable certificates for energy savings: by obligation or by some kind of incentive (voluntary demand). Imposing obligations provides for certain outcome but at the same time opens a whole new array of associated design complexities. All existing schemes rely on mandatory targets. Possibilities for eliciting voluntary demand are discussed in the section "Open issues and possible directions for development" of the present paper.

Size and unit of the target

First, the size of the energy savings target should be defined. Usually, this is a national target defined by the government and introduced in legislation. On practical level, the reference point and year for setting the target are crucial. The target can be defined, e.g., in terms of economic savings potential (e.g., savings with short payback period), or of actual or predicted consumption. On theoretical level, establishing the optimal target remains contentious because the externality issue is unclear and hence the question of which the public good is commoditized through the certificate remains unanswered[5]. As experience with renewable quotas and tradable green certificates (TGCs) shows, a target that reflects little more than business as usual is not likely to foster additional measures.

The type of effect a government wants to achieve through establishing such a scheme has a major influence on the type of trading scheme set up and its operation details, including the unit of the target (primary or final energy, carbon reductions). There is a range of policy objectives that can be addressed through energy savings obligations and trading schemes, such as security of supply, reliability of electricity supply, GHG mitigation, and local pollution reduction. The definition of compliance period (temporal content of the target) and possibly rate of increase are important from the point of view of providing security for investors and hence from the point of view of financing institutions. Significant cobenefits of a TWC scheme, such as social policy objectives (e.g., fuel poverty alleviation, job creation), increased productivity of the economy and technology diffusion should also be made explicit and quantified.

Obliged parties

A second step is to define who the obliged actors should be and how the overall target should be apportioned to individual actors. Obliged parties represent the demand side of the white certificate market: they are the ones that surrender white certificates at the end of the compliance period to prove they have met their savings obligations. An important issue is to have a significantly large share of energy consumption covered by the obligation, while retaining a manageable number of obliged parties by possibly excluding very small market actors for whom the savings obligation may pose a big burden. With regard to end-use energy efficiency, savings targets cannot be imposed on market actors "higher" in the energy chain than distribution companies[6]. A purely downstream system would target users, such as industrial users (outside EU Emission Trading Scheme (ETS)), commercial facilities, and even households; however, monitoring of such a scheme would be an impossible task. Target apportionment among obliged parties can be based on market share or number of consumers (linear or increasing for larger obliged parties).

In principle, the individual targets can be expressed as a sales percentage or as an absolute value, i.e., independently of the commercial choices of suppliers (Oikonomou and Patel 2004; Oikonomou et al. 2007). Quirion (2005) compares the distributional effects of alternative apportionment rules. It appears to be more acceptable to set targets as a percentage of the energy that distributors or suppliers sell and contingent upon the evolution of market shares rather than in absolute terms. In the latter case, under assumptions of perfect

[5] Externalities arise when certain actions of producers or consumers have unintended external (indirect) effects on other producers or/and consumers; in the presence of externalities, social benefits (costs) and private benefits (costs) differ. Externalities may be positive or negative. With negative externalities, social costs are higher than private costs: pollution is a negative externality. With positive externalities, social benefit is higher than private benefit, which leads to the undersupply of the activity by the market: the technological spillover of research and development is a positive externality.

[6] In Europe, savings obligations are imposed either on grid companies (distributors, in Italy) or on energy suppliers (retailers, in France and the UK).

competition and no public intervention in the energy market, energy suppliers' profit decreases since suppliers cannot pass the cost of certificate generation on to consumers[7]. This is likely to generate fierce opposition from these potentially obliged distributors or suppliers (Quirion 2005).

The discussion that surrounds the introduction of energy savings targets to energy distributors or suppliers is often on "philosophical" grounds questioning the role that energy distributors or suppliers can play in assisting their clients in improving the efficiency of their consumption. The arguments for involving energy suppliers in energy savings are numerous, notably the fact that they are closer to the end users. On the other side, distributors are more stable and, depending on network tariff regulation, also less under pressure to increase sales. Here, we briefly discuss the business case of end-use energy efficiency investment for energy suppliers.

From business perspective, energy efficiency investments and energy management services may constitute possible strategies for value-added services in electricity and gas retail. In theory, energy suppliers should want their customers to save energy in order to build a long-run business relationship and differentiate from competitors, establish synergies with other activities, gain a competitive advantage, and help customers choose. Historically, the involvement of utilities in the provision of end-use energy efficiency measures differs significantly across countries. Based on more than 30 interviews with electricity and gas distributors and suppliers from Austria, France, Germany, Hungary, Italy, Finland, Portugal, and the UK conducted in the framework of the EuroWhiteCert project, it has been concluded that also in practice many electricity and gas distributors and suppliers see the provision of energy efficiency and energy services as a value-added service that will be increasingly important in retaining clients in liberalized markets. While distributors and suppliers are becoming more and more customer-oriented, focused on the provision of value-added services that are crucial in retaining clients in competitive markets and in general trying to stay ahead of their customers' demands and maintain leadership in a liberalized energy market, the role of energy efficiency as a sales argument is still modest and generally distributors and suppliers do not view energy efficiency as a leading positioning strategy. The most commonly cited elements of the positioning strategy of energy providers in competitive markets include lower price (often related to portfolio management and optimization), quality of supply in terms of reliability, operation and maintenance, and global invoicing for all sites of a client or long-term contracts. A strategic response emerging is the integrated provision of electricity and gas to make complex offers and attempts to make joint offers together with energy service companies (ESCOs) to offer integrated energy services (design, implementation, management, and maintenance). While in some markets liberalization is already proving to be highly effective in raising attention towards energy saving and energy suppliers consider the provision of energy efficiency essential for their activities, in most markets clients are still cautious with integrated offers and the expectations are that the demand for energy services will become significant only upon full market liberalization and for the time being customers are interested in energy price only. On a regional level, the added benefits of energy efficiency and renewables can be communicated to the customer base.

Eligible projects: technologies, actors, energy carriers, and customer base

A crucial aspect is what projects and/or technologies are eligible under the scheme. There are two possibilities: leaving the scheme completely open to any technology, form of energy, or end-use sector or limiting the scheme with respect to technologies (e.g., establishing a list of eligible project types), end-use sectors, or energies (e.g., only grid-bound ones).

The economic textbook argument is not to give preferential treatment to any technology, form of energy, or end-use sector and to instead focus on

[7] If a white certificate scheme is designed with suppliers' targets independent of changes in kilowatt hour sales, then under a set of standard assumptions the only effect on energy price is decrease because the energy supply curves upward-sloping. However—as explained by Quirion (2005) based on a partial equilibrium model simulation—if suppliers must generate more certificates if they increase their sales, then certificates' cost is a part of their marginal cost (hence of the energy price) and is passed like a tax on to consumers. While these statements are made with an assumption of perfect markets and competition, in practice, the level of the market liberalization and the possibility to increase tariffs have profound effects too.

primary or final energy that is causing the environmental harm. A preferential treatment could lead to higher costs of compliance than if the market forces were left to determine the least-cost path to the environmental or social objective (Jaccard and Mao 2002). In addition, theoretically, the wider the scope in terms of types of projects or investment choices and the fewer limitations in terms of compliance routes, the more diverse marginal costs of compliance become and the greater the benefits of trading in terms of lowering the overall cost of compliance for obliged parties. Therefore, many project types should be allowed in order for trading to bring benefits that are sufficient to offset the associated administrative and institutional costs; in contrast, limiting the scope to certain technologies will increase the risk of price uncertainties and fluctuations. Limiting the scope of a scheme in terms of participating sectors and actors can potentially reduce administrative costs but has the drawback of marginal cost of energy efficiency measures increasing with time as lower-cost options ("low-hanging fruits") are used up[8]. Should there be a large pool of low-cost energy efficiency improvements already available, this may not be a problem in the short term. However, it will in the long term constrain further gains in energy efficiency. On the other hand, increasing marginal costs of compliance—if happening in a stable system of savings obligations designed with a long-term vision—may stimulate further technology and service innovation. In the absence of such a signal, a white certificate system is more likely to focus on technology diffusion rather than innovation.

There are some practical arguments against a comprehensive scheme that is completely open in terms of technologies and sectors and, as described above, it is entirely up to market forces to determine where and what measures are taken. First and foremost, a purely operational consideration against extensive scope is that inclusion of all project types and all sectors may result in difficult and expensive validation and monitoring of savings and a huge amount of work for regulators to design monitoring and verification methodologies. As research on emission trading shows, the positive effect of leaving it completely to market forces to decide on measures taken is only valid where the benefits yielded by each unit of compliance e.g., toe or kilowatt hour saved—are the same in whatever end-use sector or location it is achieved. If this is not the case—for instance, in cases where multiple policy objectives are addressed through the scheme, e.g., there are significant local (co)benefits—then activities will migrate to low-cost measures, sectors, or regions, which may raise equity issues and go contrary to parallel policy goals (Boemare and Quirion 2002). Because cost minimization is an inherent feature of markets, a completely open scheme is likely to focus compliance on large-scale projects, where savings are easy to monitor and economies of scale and straightforward monitoring are likely to bring a reduction in transaction costs of certification. Such a trend however may leave out certain hard-to-reach sectors, such as residential buildings, where transaction costs are higher and payback periods longer.

Since a TWC may serve to achieve multiple policy goals (for instance, social goals such as alleviation of fuel poverty as is the case in Great Britain), it is also possible to consider bonuses and/or special restrictions to encourage specific action.

Framing the demand for certified energy savings: examples from practice

With respect to *target definition*, in Italy, the energy savings targets are expressed in primary energy consumption (tons of oil equivalent, i.e., toe), imposed on electricity and gas grid distribution companies with more than 100,000 customers as of the end of 2001 and set on an annual basis for the period 2005–2009.Targets for the post-2009 period are to be fixed by the government in 2008. Current targets are just for savings achieved each year and do not include expected savings in the future. In the fifth year of the current phase, approximately 3 Mtoe of primary energy savings per year are projected to be realized, of which 1.6 Mtoe/year by electricity distributors and 1.3 Mtoe/year by natural gas distributors. This is about 1.5% of gross inland consumption in Italy. On the whole, the mechanism is planned to

[8] This effect may be even stronger if schemes are developed with short-term vision and goals subject to review. Short-termism is poorly suited to stimulating innovation in the energy efficiency market because neither new nor existing market participants will have the incentives to invest in any new technologies or services, if the schemes provide insufficient time in which to obtain a return on that investment. We are indebted for this comment to David Young.

deliver energy savings equivalent to 5.8 Mtoe (243 PJ) in the 5-year target period (Pavan 2002, 2004, 2005).

The Energy Efficiency Commitment (EEC) in the UK runs in 3-year cycles from 2002 to 2011. The EEC-1 program required that all gas and electricity suppliers with 15,000 or more residential customers deliver a certain quantity of "fuel standardized energy benefits" by assisting residential customers to take energy efficiency measures in their homes. The overall savings target was 62 fuel standardized terawatt hour[9] and the total delivered savings reached 86.8 TWh (Masero 2005). In EEC-2 (2005–2008), the threshold for obligation has been increased to 50,000 domestic customers. The target has been increased to 130 TWh. Due to carrying over of savings from EEC-1, already in 2005 more than a quarter of this target has been achieved. Certificate trading is not a feature of the scheme in Great Britain and no formal certification of attained savings takes place. While trade of obligations and of measures is allowed, little actual trading occurred so far (Capozza et al. 2006; see details later). The third phase of EEC, which will run from April 2008 till March 2011 has been renamed Carbon Emission Reduction Target (CERT).

In the French system, obligations are set for energy suppliers delivering electricity, gas, domestic fuel (not for transport), cooling, and heating for stationary applications. The obligations cover the period 2006–2008. A threshold for the imposition of a savings target is set at 0.4 TWh/year (or 5,000 l in case of domestic fuel). Obliged actors have received targets based on their physical sale quantities in the residential and commercial sectors (75%) and price (25%) that is an estimate of reference price for the 3 years before 2006. Annual adjustments of the individual obligations are made to take into account variations in the market. The system excludes plants under the EU ETS directive and fuel substitution between fossil fuels, as well as energy savings resulting from measures implemented to comply with current legislation. The total target for the first 3 years is 54 TWh (in final energy, i.e., 197 PJ) cumulated over the life of the energy efficiency actions with a 4% discount rate. The expected cost of action is below 20 Euro/MWh (Baudry and Monjon 2005).

Energy efficiency obligations without certificate trading are also in place in the Flemish region of Belgium, whereby regional utility obligations have been imposed on 16 electricity distributors. The annual target is 0.58 TWh and eligible actions refer to residential and non-energy-intensive industry and service and can involve saving fuel from any sources. Separate targets are set for low-voltage clients (<1 kV; mainly residential) and high-voltage clients (>1 kV). For the low-voltage clients, the targets are 10.5% of electricity supplied over the 6 years from 2003 to 2008 and for high-voltage users (>1 kV) 1% per annum for each over the same period[10]. The energy savings target for 2004 was increased by over 44% as compared to 2003; the targets for 2005 have been slightly increased (by 5%) over 2004 to 579 GWh, out of which 351 GWh in the low-voltage segment and 228 GWh in the high-voltage segment (Collys 2005). Unlike the other three European schemes, the Flemish one has no trading option of any type (certificates or obligations) and is thus left out of the present discussion.

With respect to *target apportionment* among obliged parties, in Italy 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 year t-2. The apportionment in Italy is linear to the market share. Ten electricity distributors, covering 96% of the electricity market, and 20 natural gas distributors, covering 60% of the gas market, are subject to targets. Italgas accounts for 34% of the gas target and among gas distributors is the market actor with largest target; there are about 500 distributors without targets (due to small size). For electricity, the amount of noncovered distributors' share in final consumption is about 2%; Enel Distribuzione has the largest market share (almost 88% of final consumption) and consequently accounts for the largest share of the target. Overall, 22% of the total obligation in Italy has not been

[9] Energy savings are discounted over the lifetime of the measure and then standardized according to the carbon content of the fuel saved. These coefficients are set as: coal (0.56), electricity (0.80), gas (0.35), liquefied petroleum gas (LPG; 0.43), and oil (0.46).

[10] The reason for the higher than 1% per annum target for the low-voltage users is because of the Flemish Parliament's decision to provide free vouchers for the head of every family in 2004 and 2005 which can be exchanged via the electricity distributor for either an energy-saving compact fluorescent lamp (CFL) or a low-flow showerhead or an energy meter.

distributed, which corresponds to the volume of small suppliers. In Great Britain, target apportionment is based on number of domestic customers; in EEC-1, the obligation became tighter for companies with increasing size, but this feature of the system was removed in EEC-2. In the French system, the distribution of obligations is based on market shares of energy sales turnover in the residential and tertiary sectors; Électricité de France accounts for approximately 50% of the obligation and Gaz de France for 25%. Suppliers with annual sales above 0.4 TWh or 5,000 l in the case of domestic fuel are subject to the obligation; the apportionment of the total annual target is done on annual basis to take into account new market players.

With respect to the *temporal* content of the target, in Great Britain, the compliance period for EEC-1 has been 2002–2005; EEC 2 runs in the period 2005–2008; there has been a roughly double increase in target between EEC-1 and EEC-2; however, due to changes in the way the savings have been calculated (discount factors, see discussion later), it is difficult to put a precise figure on the increase[11].

With respect to activities *eligible* for certification under the different national schemes, projects in all end-use sectors are eligible in Italy, along with some supply options (such as combined heat and power and solar). At least half of the target set for each single year should be achieved by reduction of the supplied energy sector, i.e., electricity and gas uses (a.k.a. the "50% constraint"; Pavan 2002). The remaining share can be achieved via primary energy savings in all the other end-use sectors. There is an illustrative list of eligible projects. Energy-saving projects contribute to the achievement of targets for up to 5 years (with only some exceptions). Energy savings accredited by the regulator Autorita per l'energia elettrica e il gas (AEEG) until June 2007 come from electricity savings in buildings (55%), heat demand in buildings (16%), street lighting (12%), generation and distribution (11%), and industrial energy consumption (6%; Autorità per l'energia elettrica e il gas 2007). The largest part of certified savings comes from early actions: in the first operational year of the scheme (2005), the regulator had to certify many projects implemented since the original starting date of the scheme (2002). The effect of such early measures undermines the effectiveness of the scheme; it is expected to significantly decrease in the coming years and many more "new" projects will be needed in order to guarantee the achievement of the targets for future years.

As of mid-2007, there were 919 registered ESCOs that could receive white certificates in Italy: it was observed that only 15% of these have demanded verification and certification of savings from projects. Of all accredited ESCOs, 12% have obtained white certificates. On the other hand, almost three fourths of all certificates issued went to ESCOs and 12% went to nonobliged distributors (Autorità per l'energia elettrica e il gas 2007).

In Great Britain, only activities concerning domestic users are eligible. At least 50% of the energy savings must be targeted at customers that receive income-related benefits or tax credits (i.e., priority group) as this condition contributes to the governmental objective of fuel poverty eradication. Projects can be related to electricity, gas, coal, oil, and LPG. Suppliers can achieve improvements in relation to any domestic consumers in the UK. Suppliers can receive 50% uplift on the savings of energy efficiency measures that are promoted through energy service activities. This uplift is limited to 10% of the overall activity.

Apart from plants under the EU ETS directive and fuel substitution between fossil fuels, no other restrictions on compliance are foreseen in the *French* scheme. Any economic actor can implement projects and get savings certified, as long as savings are above 3 GWh over the lifetime of a project, although it is possible to pool savings from similar actions to reach the threshold. Actions must be additional relative to their usual activity. All energies (including fuel) and all the sectors (including transportation and excluding installations covered by the ETS) are eligible. Certification of projects implemented by organizations, which do not have a savings obligation is allowed but only after considering the impact of the project on their business turnover. If an impact on business turnover is identified, then certification of savings is allowed only for innovative products and services. An innovative product in this context means that its efficiency is at least 20% higher compared to standard equipment and its market share is below 5%.

[11] If the illustrative set of measures under EEC-1 were subject to the same set of assumption applied in EEC-2, the terawatt figure would fall from 81 to 66 TWh (Doughty).

The Flemish obligation envisages that each year each grid operator submits a plan with actions for the next year and actions must contain financial support, awareness-raising and information campaigns[12], and proposal for calculation of the energy savings (Collys 2005).

White certificates—the tradable commodity

It is important distinguish between certification of energy savings and trading of white certificates. In principle, trading is not a precondition for certification: certificates can be used as a simple accounting tool to prove that a certain amount of energy has been saved and to verify compliance with energy savings targets or with other obligations or to qualify for, e.g., state support (subsidies) or preferential taxation.

What is a certificate? Certificate delineation and validity

A certificate is an instrument that provides a guarantee that savings have been achieved due to a specific measure; therefore, it can be used for different energy policies, such as tax credits and fiscal incentives. Each certificate should be unique, traceable, and at any one time have a single owner. Certificates need to be a well-defined commodity that carries a property right[13] over a certain amount of additional savings and guarantees that the benefit of these savings has not been accounted for elsewhere. Property rights must be clear and legally secured as it is unlikely that trades will occur if either party is unsure of ownership (Jaccard and Mao 2002). Minimum project size may be applied for certification of savings in order to reduce transaction costs and encourage pooling of projects (Pavan 2002). The size of a certificate has important implications for the number of parties that can offer certificates for sale (unless other restrictions apply). The validity and any associated intertemporal flexibility embodied by banking and borrowing rules, the rules for ownership transfer, the length of the compliance period, and expectations of market actors about policy stability and continuity will all influence the market for white certificates. A long certificate lifetime and banking increase the elasticity and flexibility of demand in the long term. To mitigate the uncertainties about the achievement of the quantified policy target within the prespecified time-frame, banking for obliged parties may be allowed only once they achieve their own targets.

In Italy, certificates are expressed in primary energy saved and the unit is 1 toe and are valid for 5 years[14]. Unlike in the other two schemes where compliance is demonstrated at the end of a multi-annual period, in Italy, the obliged parties have to demonstrate compliance annually in the period 2005–2009.

The first stage of the French scheme covers a 3-year period; in Flanders, there are annual targets for the period 2004–2007. More details on temporal aspects are available in the section on tools for mitigating certificate price volatility.

Depending on the measurement and verification approach adopted (see later), the following thresholds apply on projects that can be certified in Italy: for "default approach" 25 toe/year, independent from the type of project proposer, for "engineering approach" certificates 100 toe/year for obliged actors and 50 toe/year for nonobliged actors, for energy monitoring plan 200 toe/year for obliged actors and 100 toe/year for nonobliged actors[15]. An implication of the fact that certificates are valid for five consecutive years (or eight in some cases) is that nonobliged parties (ESCOs) bear a risk about the cost of certificates beyond 2009: despite the fact that a project implemented in 2007 will generate savings in the period 2007–2011, there is no reasonable way to speculate about certificate prices beyond 2009. While the Italian government is expected to prolong the scheme, this situation signals the need for investment security via clear policy continuity that is often indicated in various discussions about market-based instruments.

[12] No energy savings are attributed to either information or awareness raising even though these are included in the actions.

[13] According to Faure and Skogh (2003), effective property rights have to fulfill the following criteria: (1) the owner must be able to enjoy the benefits and influence the costs generated by the resource and the owner's effort; (2) it must be possible to enforce rights and duties privately and/or publicly; and (3) the owner needs to be able to contract with other parties involved.

[14] Except for some measures, such as buildings thermal envelope, bioclimatic design, reduction of cooling needs, etc. that are valid for 8 years.

[15] We are indebted for this comment to Nicola Labanca.

In France, certification is allowed above a threshold of 3 GWh of savings over the lifetime (Baudry and Monjon 2005); smaller projects can be grouped together to reach the threshold for applying for certification, i.e., the threshold is per application for certification and not per project. In France, the value of the certificate is based on the final energy saved, the unit is kilowatt hour Cumac (cumulated over the lifetime and discounted). The certificates are delivered after the programs are implemented but before energy savings are realized.

Trading rules

Rules defining trading parties are also important for market liquidity. Provided that administrative and monitoring costs are not disproportionate, as many parties should be allowed to trade in the scheme as possible, since this enhances the prospects of diversity in marginal abatement costs and lowers the risks of excessive market power (Pavan 2003). Parties that may be allowed to receive and sell certificates include obliged actors, exempt actors, ESCOs, consumers, market intermediaries, nongovernmental organizations, and even manufacturers of appliances. A key benefit of allowing many parties in the scheme is that new entrants may have the incentive to innovate and deliver energy efficiency solutions, which have a lower marginal cost.

In Italy, certificates are issued by the electricity market operator upon request of the regulator AEEG to all distributors and their controlled companies and to energy service providers and ESCOs. Certificates are tradable via bilateral contracts or on a spot market organized and administered according to rules set out jointly by AEEG and the electricity market operator. There are three types of certificates and thus three markets—for electricity savings, for gas savings, and for savings of other energy carriers. This differentiation is required in order to allow the enforcement of the “50% constraint.” The three types of certificates are only partially fungible. The first market sessions were held in March 2006. For the time being, the volume of trade is lower than expected and the largest share of trading is occurring over the counter (OTC): 76% of certificates were traded under bilateral contracts (Grattieri 2007).

In France, any economic actor can undertake savings actions and get certificates as long as the savings are at least 3 GWh over the lifetime of a measure. There is no formal market organized by the national administration; therefore, there are only OTC trades between obliged subjects and between project implementers and obliged subjects. There is a registry with information on white certificates[16].

In Great Britain, there are no certificates in the strict sense of the word. The scheme covers obliged parties and no other party can receive verified savings that can be used to demonstrate compliance with the savings target. Suppliers may trade among themselves either energy savings from approved measures *or* obligations, with written agreement from the regulator. The lack of formal certification and the fact that most suppliers use the same contractors to undertake the work explain the limited trading in measures. Trading of obligations has been bilateral and limited to the final stages of each target period when suppliers reconsider their performance against the target. In general, there has been very little incentive for suppliers to trade in EEC-1 and EEC-2 (Capozza et al. 2006). In addition, measures can only be traded once the supplier’s own energy savings target has been achieved. Three possible trading situation are identified in the Great Britain scheme: trade between suppliers (virtually nonexistent); banking between compliance periods (very common, 20% of the EEC-2 target was achieved in EEC-1); and trade between suppliers and project developers (suppliers have contracted out most of their measures to third parties). Suppliers were also allowed in principle to trade excess energy savings into the national emission trading scheme as carbon savings; however, the linking of carbon savings to the national emission trading scheme was never formalized.

Penalties and certificate reserves

A primary concern of regulators is to reduce the risk of high costs to society. This can be achieved by imposing a price ceiling for compliance: either by setting a buyout price or a predefined penalty (Pavan 2003). Predefined noncompliance penalties, minimum or maximum buyout prices, and certificate reserves attained by the regulator are tools to mitigate price

[16] www.emmy.fr

volatilities. Recycling the revenue collected from penalties to overcomplying parties enforces the effect of a penalty by increasing the opportunity costs of noncompliance.

In Italy, the sanctions for noncompliance have to be "proportional and in any case greater than investments needed to compensate the noncompliance" (Pavan 2002). There are two types of noncompliance: with the 50% constraint for action concerning an actor's own energy vector and with the general obligation. The proposal is that the unit value of each of the two penalties equals the bigger value between a level to be defined at the end of the consultation process and the average market price of the certificates in the previous year, multiplied by a factor greater than one. The idea behind this is not to predefine a potentially distortive reference price for certificates; in practice, this means that there is no ceiling of the unit cost of certificates that will act as a cap of the overall cost of reaching the target (Pavan 2002). Undercompliance in 1 year has to be recovered in the following 2 years: the monetary penalty does not cancel the obligation (Grattieri 2007).

In Great Britain, the regulator Office of Gas and Electricity Markets has the power to consider whether it is appropriate to set a penalty for noncompliance. However, there is no specific guidance on how this penalty would be calculated other than the indication that suppliers that do not meet their individual target may face a penalty fee that can be up to 10% of supplier's turnover. In the French system, a penalty of 0.02 Euro/kWh noncompliance is envisaged. In Flanders the noncompliance penalty is 0.1 Euro/kWh and the fine cannot be passed in the tariffs.

Processes to support the scheme

A sound institutional structure is needed to support a complex policy portfolio with TWCs: it involves administrative bodies to manage the system as well as processes such as verification, certification and market operation, transaction registry, and detection and penalization of noncompliance. Two issues deserve special attention for their fundamental role in institutional infrastructure of TWC schemes: baseline setting to measure the impact of projects and choice of verification system. We discuss the theoretical premises of these in the present section, giving brief examples from existing schemes.

Baselines and additionality

To determine the energy savings resulting from an energy efficiency activity, the eventual energy consumption has to be compared to a baseline (reference situation) without additional saving efforts. The choice of the reference scenario—in terms of reference consumption and conditions—raises some challenges. These are related to issues such as determining the relevant system boundary, minimizing the risk of producing leakage, the practicality and cost-effectiveness of a baseline methodology, and treating no-regret measures in the baseline determination[17].

Additionality refers to certification of *genuine* and *durable* increases in the level of energy efficiency beyond what would have occurred in the absence of the energy efficiency intervention, for instance, only due to technical and market development trends and policies in place. While in practice projects tend to have a mix of public and private benefits, the cost of disaggregating these benefits and precisely accounting for the exact share of no-regret measures in a larger action may be prohibitively high. One way of overcoming this problem would be to place an objectively defined discount factor on investments, which accounts for these private benefits (see discussion on "Discount factors" later). Furthermore, the electricity price and the effects of the EU ETS and other policies in place (such as taxation or standards), which inevitably affect the amount of energy efficiency measures taken, should also be accounted for in the baseline to ensure genuine additional savings. Nevertheless, it is also widely acknowledged that many low- or no-cost energy efficiency measures do not occur because of the presence of numerous barriers.

In Great Britain, the Department for Environment, Food, and Rural Affairs (DEFRA) requires suppliers to demonstrate clear additionality in each of the schemes they carry out—for instance, schemes must go beyond building regulations or involve the installation of appliances better than the market average. For accreditation purposes, it is difficult to assess what the business-as-usual level actually is because this is dependent on the personal judgment of individual consumers. A business-as-usual trend across the economy is accounted for in the calcu-

[17] We are indebted for these comments to Ole Langniss.

lations to assess overall carbon saving from the program. A characteristic feature of compliance routes in Great Britain is the negotiation of the rebate for energy efficient equipment between equipment manufacturer–supplier and energy suppliers. It is the efficient equipment manufacturers, installers or consultants approaching energy suppliers to enquire how much they will receive for enlarging the market.

In Italy, savings have to go over and above spontaneous market trends and/or legislative requirements (Pavan 2004, 2005). The business-as-usual trend shall be adjusted with time: taking replacement of refrigerators with more efficient models as an example, one may assume that, if in 2005 the reference trend in the economy is class A, in 2007 it should be A+ and in 2009 perhaps A++. Clearly, the nature of the check differs for different project types: e.g., installation of efficient equipment may be evaluated on the basis of difference with national average installed or with what is offered in shops. For projects that are based on the deemed savings and engineering verification approach (see explanation in the next section), there is a case-by-case additionality check performed by the regulator. The largest electricity distributor Enel Distribuzione (which has above 88% of the electricity target) has organized a big CFL giveaway campaign (seven million CFLs in 2007) and is also covering a 10% rebate on A-class appliances. Enel is entitled to all the 100% savings resulting from the selling of the A-class appliance, which may pose some uncertainties about ownership of savings.

Measurement, verification, and certification: theory and practice

Energy savings can be determined by estimating energy consumption or metering consumption *before* and comparing it to the consumption *after* the implementation of one or more energy efficiency improvement measures and adjusting for external factors such as occupancy levels, level of production, etc. In principle, adjustments for energy consumption changes caused by behavioral and lifestyle changes can be introduced too as well as changes in products that deliver the same energy services. Taking into account all these possible adjustments shows that energy savings, in addition to being the result of energy efficiency measures, can be caused by changes in behavior and lifestyle and the products–installations used—which may or may not mean changing the level of service provided.

Possible verification approaches are metering or standard savings (also referred to as deemed savings). The former approach implies metering real energy consumption and calculating savings (possibly with climate or weather corrections) based on consumption before and after the energy efficiency improvement is carried out. The latter approach implies standard formulas for energy efficiency measures (e.g., a given number of CFLs installed in the residential sector is equivalent to a given quantity of kilowatt hour saved). Under a deemed savings approach, verification includes only checks whether calculations are correct, as well as checks on products sold, for example. There can be various combinations of the above, such as sampling of metering.

In principle, the metering approach is a more accurate guarantee of energy saved than the standard factors approach (the latter approach cannot verify details such as location and operating hours of installed CFLs), but in practice it can be difficult to identify the actual saving (e.g., in households, there is only one meter for all electricity usage which increases each year due to growth in appliances and can fluctuate with changing household numbers, lifestyle, weather, etc.). It may be reasonable for large installations or projects but may result in high monitoring costs for projects of smaller size (Pavan 2004, 2005). 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). On the other hand, sample surveys can be used to calibrate savings attributed to projects using standard factors: for example, metering a sample of 1,000 households in 100,000 CFL giveaways to establish operating hours and other factors that determine consumption (as in clean development mechanism methodologies).

Monitoring and verification methods have an impact on certification of savings. Certificates can be issued either *ex-post* and thus they represent the energy saved over a specified period of time, or they can be issued *ex-ante* and thus represent an estimate of the energy to be saved over a specified period of time. With regard to ex-post certification, there are different options: 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 latter option will make the system more comparable to a green certificate system where the certificate has a unique time of issue attached to it and indicates the period over which and the location where energy has been saved and by whom it has been saved (initial owner of the certificate). However, ex-post certification will probably increase validation efforts and verification costs. In addition, ex-post certification would only allow project developers to obtain certificates after project implementation, which would have implication on market liquidity. Alternatively, for projects that can be evaluated through a standard savings approach, certificates can be granted in advance (*ex-ante)* of the actual energy savings delivery. This will mitigate liquidity constraints of project implementers and allow them to finance new projects. If underperformance is detected at the end of the lifetime of the measure, the underperforming project owner should be asked to cover the shortage with certificates purchased on the spot market[18].

The Italian TWC scheme uses three valuation approaches: a deemed savings approach with default factors for free riding, delivery mechanism, and persistence; an engineering approach; and a third approach based on monitoring plans whereby energy savings are quantified via a comparison of measured or calculated consumptions before and after the project, taking into account changed framework conditions (e.g., climatic conditions, occupancy levels, production levels). All monitoring plans must be submitted for preapproval to the regulatory authority AEEG and must conform with predetermined criteria (e.g., sample size, criteria to choose the measurement technology, etc.; see Pavan 2004, 2005). Most of the projects submitted to date are of the deemed saving and engineering methods. There are 22 approved evaluation procedures. There is ex-post verification and certification of actual energy savings achieved on a yearly basis[19] (Oikonomou et al. 2004 and references herein). In 2005, for 70% of the certified saving, the deemed saving approach was used; the engineering approach was used for about 20%, while the monitoring approach was used only for 10% of the certified savings.

In Great Britain, the savings of a project are calculated and set when a project is submitted based on a standardized estimate taking into consideration the technology used, weighted for fuel type, and discounted over the lifetime of the measure. There is limited ex-post verification of the energy savings carried out by the government in order to inform the design of standardized estimates in future periods.

In France, a list of standardized actions with the saving evaluation method has been published in June 2006. The standard actions currently introduced include 31 in the residential sector, 22 in the commercial sector, three in the industrial sector, and three in the transport sector.

Finally, in the Flemish region of Belgium, grid operators submit to the Department of Natural Resources and Energy of the Ministry of Flanders plans for actions to be implemented in the following year. These plans also include proposals for the calculation of energy savings. Measures can refer to all fuels; the target is expressed in primary energy savings and electricity savings are enhanced by a factor of 2.5. The department then evaluates the method for calculation of savings. Every year, grid operators are obliged to submit to the Flemish Regulator (VREG) an evaluation report about the implementation of measures during the previous year (Collys 2005). In case of noncompliance, the regulator starts legal proceedings for collecting fines.

[18] One should note however that this suggestion is rather difficult to implement in practice for two major reasons. First, it requires the monitoring and evaluation of the actual energy performance of the project in order to allow the comparison between the lifetime energy savings accredited in advance and the real savings. Second, most of the energy-saving measures have quite long lifetimes; therefore, the comparison between real savings and accredited savings could only be made many years in the future (and many years after the first compliance checks).

[19] e.g., in the case of CHP, the plant operator has to prove that the plant has run a certain number of hours, etc.

Discount factors

In the British and French schemes, there are discount factors for accounting the annual savings of different measures with different life spans. While one can argue that a CO_2 driver for a TWC scheme would make discounting unnecessary, the role of the discount factors can be seen as accounting for the "deterioration" of a measure over its lifetime.

In France, the discount factor is 4%. In Great Britain, the discount rate has been decreased twice: in EEC-1, the discount factor used was 6%, while in EEC-2 the factor was down to 3.5%, as decided by the treasury in January 2003 in order to reflect prevailing circumstances. In CERT (EEC-3), the discount factor is zero.

Changing the discount rate "increases" savings coming from projects thus decreasing the size of the target: the same goal with a lower discount factor is a lower and easier-to-reach goal in practice, for the case of Great Britain, from 62 to 81 TWh fuel standardized lifetime-discounted savings (Morley 2004). In the case of Great Britain, the reduction of discount rates has favored the measures with longer life cycle.

Cost recovery (optional feature)

Cost recovery is a process whereby an energy distributor is able to recover, through rates, the costs of implementing any type of energy-saving action beyond the consumers' meter[20]. Cost recovery via regulated tariffs can only be applicable where electricity and gas markets are not fully liberalized and/or where the obligation is imposed on grid companies. Since cost recovery is linked to regulated tariffs, it is not applicable in fully liberalized markets whereby the obliged parties are energy suppliers who can pass the additional cost of compliance to the final user (as is the case of Great Britain).

With perfect competition assumed, all customers will bear the same specific burden of the costs incurred for savings project implementation by energy suppliers. In practice, suppliers may shift the financial burden of energy savings obligation to less-competitive market segments.

In Italy, where the obligation is imposed on distribution grid companies, cost recovery of 100 Euro is allowed for each type I *and* type II certificate delivered by the distributor as long as the distributor total savings target for the year under consideration has not been achieved. Cost recovery is also allowed when the intervention concerns measures on the customer base of another distributor or measures that save energy on an energy carrier different from the one of the distributor. The cost recovery is net of any contribution from other sources. The cost recovery is administered by a fraction of electricity and gas network tariffs going to a fund disbursed by the regulator in such a way that each obliged actor can receive 3 Eurocent for each kilowatt hour saved to achieve the savings target. Cost recovery is allowed for savings projects only until an obliged party reaches its target. Nevertheless, the existence of cost recovery has largely biased actions towards savings in electricity and gas, undermining primary savings projects (where no cost recovery applies). As of the end of 2007, the regulator considers reducing the 100-Euro/toe cost recovery and differentiating it for electricity and gas; proposed levels are 46 Euro/toe for electricity and 80 Euro/toe for gas (Grattieri 2007). The impact of cost recovery in the case of electricity (rate adders) has been estimated at 0.6 Euro/year for an average family (Grattieri 2007).

The French scheme stipulates rises in prices and tariffs to be limited to a maximum of 0.5%. In Flanders, the savings obligation is incorporated in the electricity tariffs as a public service obligation.

Finally, while cost recovery aims to compensate suppliers for the investments in end-use energy efficiency measures, there are also larger economic effects of overall energy demand reduction caused by the application of a scheme with energy savings obligations: these are related to possible price reduction for energy purchased at the wholesale markets by suppliers, due to among other deferred and avoided investment in electricity generation plants and network upgrades.

Open issues and possible directions for development

This section raises a few issues that so far seem to have been forgotten by policymakers and researchers.

[20] These costs can include rebates and measure implementation costs and expenses. A key element of cost recovery is the prudence review. In contrast, lost revenue recovery is a process whereby a utility estimates the amount of energy sales that did not occur due to the end-use energy efficiency efforts. We are indebted for these clarifications to Steven Schiller. Lost revenue recovery is not a feature of white certificate systems in Europe.

First of all, the conditions for ownership over savings should be carefully defined. For example, energy suppliers can claim towards their target the total energy savings that flow from a partnership project regardless of the actual financial contribution made by the supplier. While one can claim that an energy-saving scheme would not have gone ahead without support from a supplier regardless of the precise share of their financial contribution, the issue is whether it is acceptable to allow ownership over 100% of energy savings flowing from a 10% subsidy offered by suppliers of insulation, for example. This distributional issue is partially solved by involving ESCOs that recover their investment with the revenue stream from savings achieved, including the income from selling TWCs. In addition, issues related to ownership of savings and/or white certificates can be resolved in the contract between the project developer and the client. In the EEC framework, house owners transfer ownership of their energy savings to a supplier in return for a grant or subsidy; it has been indicated, however, that the house owners are not necessarily aware that they are transferring something with a value.

Second, while cost recovery is present only in the Italian scheme that places the obligation on grid companies, more attention should be placed on its design especially when it comes to solving the issue of accounting for energy efficiency expenditure in tariff or cost structures. In addition, a flat rate of cost recovery can have a distorting effect: for example, in Italy, the fixed cost recovery (100 Euro/toe) so far exceeds the price of TWCs. The existence of many low-cost actions signals that suppliers are generating windfall profits from the system. Nevertheless, early evidence shows that the cost recovery is below the corresponding cost of a toe of electricity or gas; the cost recovery rate is in a process of revision by the regulator.

Third, the issue of national TWC schemes versus an integrated European one needs more attention. Clearly, existing schemes in Europe are entirely different and impossible to integrate at present. While harmonization of M&V approaches may be a difficult but not impossible task, the strong local benefits of energy efficiency will likely spur opposition against Europe-wide trade where consumers in more efficient countries may end up paying for cheaper energy savings supported by their supplier in another country. Another important point when discussing an EU white certificate scheme are targets. There are two major options: either national targets and European integration of certificate markets or a common European target along with integration of certificate markets. In the case of national targets, these would have to be equally ambitious.

Fourth, in principle, there is a possibility to extend a TWC scheme to the transport sector, imposing similar obligations on oil distributors.

Finally, the case for a voluntary market in TWCs built on the possibility to trade carbon savings into an emission trading regime is interesting, even if complicated. Because energy savings bring a precisely measurable carbon reduction, white certificates can be converted into emission allowances that can be sold on the emission market. Energy efficiency and renewable energy facilities generate emissions offsets that firms under an emission cap can purchase to meet their targets. Allowing certain types of activities outside the formal emission cap to be recognized for the emissions reductions these projects provide can potentially create a voluntary market for white certificates. One practical arrangement for bringing white certificates under an emission trading regime is via a set-aside quota within an emission trading scheme. A set-aside is a pool of allowances that are kept by the program administrator in charge of emission trading and used to reward energy savings; this will influence the market towards more such projects[21]. A set-aside can be calibrated to allow obliged parties to exceed their emission caps provided that they submit sufficient green and/or white certificates to cover these surplus emissions. This option will not compromise the environmental integrity of the emission cap because renewable and energy savings projects have a carbon component. Thus, the existence of a savings target is not a precondition for introducing white certificates into emission trading. Provided there is a mechanism to certify energy savings in some sectors and convert these in CO_2 allowances and bring them in the emission market through a set-aside, voluntary white certificates would then probably be created to purely respond to the

[21] Energy efficiency or renewables set-aside quotas have been developed and introduced by six states in the NO_x Allowance Trading Program in the USA.

needs of the carbon market. Voluntary certification would however need independent verification.

On the practical side of integration, the major difficulty is the fact that emission trading is a cap-and-trade regime with ex-post measurement, while certificates schemes are baseline-and-credit ones with a large share of ex-ante measurement. In addition, double counting has often been raised as an issue in the context of the EU ETS. The concern of double counting with regard to electricity savings and savings related to district heating that have an indirect impact on district heating (DH) installations under the EU ETS deserves special attention. These electricity-saving measures or measures that reduce heating consumption on premises heated by DH installations above 20 MW undertaken within the EU cannot be converted in a straightforward manner into CO_2 credits and imported into the European carbon market because this would result in the same amount of CO_2 accounted for twice. A practical solution would be the existence of reserve margin for implementing projects that generate carbon credits: this can be done via a set-aside quota. Different and much less complicated is the case of savings in natural gas or heating oil on non-EU ETS premises. A residential or tertiary building insulation project (in a building heated by a gas or oil boiler) can bring genuine and additional to EU ETS carbon reduction that are otherwise not covered by the EU ETS and that can be accounted for via a white certificate and converted into a carbon (project) credit, which could be used in the EU ETS. Such nonelectricity savings undertaken in sectors outside the EU ETS ones represent genuinely additional emission reductions to the EU ETS that are easily accountable. Further details on the early discussion of integrating end-use energy efficiency and white certificates in emission trading is available in Rezessy et al. (2006, 2007).

Summary and conclusions: what has (not) worked?

This paper has described the concept, the main elements, and the overarching principles and issues related to the establishment and practical functioning of a system with tradable certificates for energy savings. It has illustrated the functionalities of the concept by giving examples with key design and operational features of existing schemes in Europe, such as the target setting and apportionment, eligibility of implementers and technologies, certificate definition, and trading rules, and pointed out key issues such as the additionality criterion, baseline setting, and measurement and verification. Table 1 summarizes the basic features of the three major European white certificate systems in place. As can be seen, even if these national implementations are conceptually similar, the exact design of their major elements brings some marked implementation differences.

Taking into account the early stage of developments and the limited track record of TWC schemes, it is difficult to point at optimal design choices. The success of a TWC scheme inevitably depends on national policy contexts and priorities. Nevertheless, a set of early general observations and some country-specific conclusions can be extracted based on the discussion provided in this paper.

First of all, similar to the US-style demand-side management (DSM) systems and the Danish electricity savings obligation, the three schemes reviewed in this paper are in reality dominated by subsidy measures, i.e., obliged parties subsidize partially or entirely (e.g., CFL giveaways) energy efficiency measures. Financial incentives for end users especially in the residential sector are an important tool to get them to adopt energy efficiency measures. Compared to traditional DSM, whereby utilities are obliged to spend a certain amount of money on energy-saving programs and there is no “guarantee” on amounts to be saved, TWC systems in principle work in the direction of both assuring savings are delivered and making incentives for implementing cost-effective projects (for more details, see Bertoldi and Rezessy 2006).

Second, the three reviewed schemes are dominated by “deemed savings” measures, i.e., standard project types whereby savings are precalculated based on standard factors. In practice, deemed savings keep the costs of the scheme reasonable. A scheme limited in terms of scope is more likely to use more deemed savings because there is only a limited number of saving options available, which are normally carried out in large numbers. This is the case in the UK, where all savings are “deemed savings.” The deemed-savings method could be adjusted free riders, as done in EEC.

Third, the schemes have all some supply options included (in UK, introduced in CERT that will start in

Table 1 Features of existing white certificate systems in Europe

	UK (EEC 2, 2005–2008)	Italy	France
Unit of target	Terawatt fuel weighted energy benefits	Tons of oil equivalent, annual	Terawatt lifetime-discounted
Duration of current phase	2005–2008	2005–2009	2006–2008
Sectoral coverage for eligible projects	Residential consumers only	All consumers	All consumers (no measures from plants covered by the ETS)
Restrictions on compliance	50% from "priority group" (low-income consumers on social benefits)	50% from reduction in own energy sector (electricity and gas)	
Obliged parties	Electricity and gas suppliers above 50,000 residential customers served (15,000 in EEC 1)	Electricity and gas distributors above 100,000 customers served	Electricity, gas, LPG, heat, cold, and heating fuel suppliers with energy sales of 0.4 TWh/year or greater
Trading	No certificates; obligations can be traded; savings can be traded after own obligation met; no spot market; one-way trade in national emission trading scheme	Certificate trade; spot market sessions; OTC trading	Certificate trade, only OTC trading
Institutional structure	Energy regulator OFGEM	Energy regulator AEEG + electricity market operator GME	Ministry of Industry + French Agency for Energy Management (ADEME)
Penalty	No specific guidance on how penalty would be calculated; penalty can be as high as 10% of the supplier's turnover	Fixed by the regulator taking into account, inter alia, the actual possibility to meet the target (i.e., number of certificates issued as compared to the annual target), the magnitude of the noncompliance, and the state of affairs of the noncompliant party	0.02 Euro/kWh

Source: (Rezessy et al. 2006)

2008). In some cases, options are allowed that are "in-between" supply and end-use options, namely micro-cogeneration and solar heaters that replace end-use technologies, such as boilers.

In terms of country-specific design conclusions, while the Italian scheme is delivering the savings, it has inherent issues to resolve in terms of very low targets in the first 2 years compared with the potential, also related to the fact that almost two thirds of the savings realized during the first year of system implementation were due to saving measures implemented before 2005. As of June 2007, savings amounting to 240% the 2006 target have been awarded (Autorità per l'energia elettrica e il gas 2007). Five times more electricity savings have been certified than gas savings: this is also related to the different price for the two types of certificates. As a consequence, there was a strong price drop of electricity certificates. While early measures should decrease in the next years, they significantly lower the systems effectiveness to deliver savings. Furthermore, 22% of the total obligation has not been distributed (suppliers below the threshold) and at the same time there is a large (monopolistic) obliged subject in the electricity target. In addition, cost recovery of 100 Euro/toe goes beyond the real cost of some savings projects, this is now under discussion. Windfall profits for distributors undermine the cost efficiency of the instrument. There is insufficient information among end users about the Italian TWC and the existing energy savings opportunities. Finally, most of the trading activity is bilateral over the counter, which allows no transparency and can potentially lead to price volatility. On the positive side, ESCOs have received 72% of all certificates issued, which shows that the scheme supports ESCO operation; another 12% of all certificates were attributed to nonobliged distributors and 15% to obliged distributors (Autorità per l'energia elettrica e il gas 2007).

Experience from EEC-1 in Great Britain shows that a significant share (56%) of the 86.8 TWh of savings delivered in the period 2002–2005 came from building insulation (wall and loft). CFLs accounted for 24% of the savings achieved, followed by appliances (11%) and heating measures, mainly condensing boilers (9%) (Masero 2005). CFLs accounted for the largest number of projects undertaken (almost 40 million measures related to CFL installation in EEC-1), followed by almost six million refrigerators, freezers, and washing appliances (Lees 2005). All but two suppliers—who went into administrative receivership—achieved their targets; six suppliers exceeded their targets in EEC-1 and carried over their additional savings to EEC-2. Energy suppliers in EEC-1 have delivered more cost-effectively than the DEFRA illustrative mix. The cost of saving a delivered unit of electricity or gas was 1.3 and 0.5 p/kWh, respectively—much less than the prices to consumers (Lees 2006). In practice, EEC has been a "tendering" system, whereby suppliers tendered to energy efficiency industry (e.g., manufacturers and installers) projects to deliver them savings.

While the EEC has been very successful, this is not a real white certificate scheme as there is no market for certificates. Part of its success has possibly also been due to the limited coverage of the scheme (residential sector only), which makes design and operation easier. According to the National Energy Efficiency Action plan of the UK under the Energy Service Directive, the scheme is to be extended in scope. At this early stage of the Italian (and very early for the French) scheme, it is difficult to give "prescriptions" about the optimal setup concerning the subjects under obligation, the sector covered (this is also linked to other policies such as eradication of fuel poverty or increased competitiveness of the commercial–industrial sectors), or trading rules (no trading, bilateral transactions, or exchange). It should be emphasized that a liquid market—both in terms of demand and supply is a prerequisite for realization of the economic benefits attributed to market-based instruments. The lifetime of measures, the redemption period, banking and borrowing of certificates, the definition of parties that can acquire certificates, and the design of noncompliance penalties all have an impact on market liquidity and stability. More experience will soon be gained through the new French scheme and the possible introduction of white certificate schemes in other European countries.

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