Simulating a European-wide white certificates scheme: design issues and main lessons

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Abstract

The European Institutions are declaring a new commitment to strongly enhance the uptake of energy efficiency in the European Union. New Directives have been formulated (e.g. the Directive on promotion of energy efficiency and energy services) and the Green Paper on energy efficiency was issued to act as a catalyst to this renewed policy uptake.

The EuroWhiteCert (EWC) project, supported by the European Commission contributes to the conceptual and technical development of tradable white certificates systems covering energy savings and energy efficiency. One of the questions considered by EWC project is whether tradable white certificates will remain national management tools or may become a real European market. In this framework, the concept of a tradable white certificate system is tested by means of a pilot test which explores the practical implementation of a white certificate scheme by developing a uniform measurement and verification methodology, certifying existing projects, identifying a set of alternative market participants and analysing what could be the design of a EU-wide tradable white certificates scheme.

Based on past experiences led in the framework of Kyoto protocol implementation, several designs of a white certificates systems have been highlighted and tested trough three dynamical simulations in which physical players represented real actors likely to be involved in such a system. The third and last simulation (EWC 3) brought some interesting quantitative results, pointed out the specific difficulties of such a scheme, and allowed EWC partners to propose recommendations for promoting the implementation of tradable white certificates scheme.

Introduction

The EuroWhiteCert (EWC) project, supported by the European Commission contributes to the conceptual and technical development of tradable white certificates (TWC) systems covering energy savings and energy efficiency. The project commences with reviewing and examining broader experiences with white and green certificates issuing and trading and with analysing interactions and integration of white certificates concept with other policy instruments. Then it gradually moves in the direction of practically testing the implementation of a white certificate scheme, which wants to bring answers, among other ones, to the following research questions:

- what are the typical and alternative market participants ?
- what are the consequences of the diverse possible design on the system efficiency ?
- Practically what are the best estimates of potential benefits and costs of white certificates ?

The most appropriate way to bring answers material to these questions and to take into account possible non-rational behaviours seems to build a simulation of a white certificates scheme like it has been done few years ago within the framework of works for implementing the Kyoto Protocol and in particularly the emission allowances trading system.

After a review of past experiences dedicated to the simulations of market-based instruments for decreasing pollution or carbon emissions, this paper deals also with the building of the experimental design implemented within the framework of EWC project and presents the main lessons drawn from these white certificates scheme simulations.

Past experiences of market-based instrument simulations

The first simulations of tradable certificates systems appears in the literature in 1993 within the Acid Rain Program implementation (creating a market for sulfur dioxide emissions) These simulations wanted namely to simulate and issue recommendations for optimising the auction design. It was also demonstrated that this kind of experimental exercise can highlight some biases in the conception of new systems, in particular in the conception of new market-based instruments.

But most important experimental exercises have been done again within the Emission Trading System (ETS) implementation between 1997 and 2002. The three main simulations are called IEA simulation (2000), GETS (1999-2002) and BASREC (2002).

TESTING THE EFFICIENCY OF A COMPLIANCE TOOL

IEA 2000 Simulation (Baron, 2000)

The simulation led by the International Energy Agency (IEA), which took place in 2000, was a simplified version of the ETS under negotiation at this time within the framework of Kyoto protocol implementation. Built for observing the development of a global market, the IEA simulation gathered 17 participants (we will talk about "players" in the following of this paper) together, which represented states. At this time the players were closely linked to the negotiations of the Kyoto Protocol flexibility mechanisms, as delegates, advisors to delegations or private sector players.

The simulation covered the period from 2000-2013 in four weeks with eight trading sessions, each corresponding to one period lasting from one to three years (i.e. a non constant time range). During these sessions, the players can operate on two levels in order to comply with their carbon emission objectives:

- Each country had got a simulation tool (computing module) representing its emissions and the domestic policies and regulations he could implement in order to reach its carbon emissions target. The implemented policies were translated into a fictive domestic carbon tax that modified national emissions profile. These modules were documented by already existing studies led by IEA, which allowed representing the marginal cost curves of CO_2 emissions abatement for the participating countries.
- Each country could participate to a market of carbon emission allowances trough an electronic exchanges platform, by sending one purchase offer and one sale offer at each session. An auction system computed answers from these offers and gave the results anonymously to each participant. In addition, the players could enter bilateral transactions.

The players were expected to minimise cost (given with the fictive currency unit "mony" in order to avoid the players relying any precedent knowledge) for complying with their given objectives (these objectives were consistent with those of Kyoto protocol). No penalty for non-compliance was implemented in the simulation: the players were expected to 'play the game' without any material remuneration.

Main outcomes

This experience was not designed to test rules related for eligibility, market design, liability, non-compliance measures, etc. although some observations could be drawn from the simulation results. But it allows proving that an emission allowances trading system, such as the simulated one, reached to comply the emission objectives drawn in the framework of Kyoto protocol.

Bilateral transactions represented only 13 % of total exchanged allowances amount, but contrary to the 'real' world, the bilateral transaction system brought no additional commodity compared to the public market and thus did not represent very interesting opportunity for the players. Moreover using this type of exchange increased time spent for negotiations and thus the corresponding transactions costs for the players comparing to the public market place. Finally, the resulting prices of exchanged allowances by bilateral transaction were slightly higher than on the public market place. As a consequence, the players did not use largely this way to exchange allowances but the simulation authors seems to mean that some features should have been introduced in the simulation design for taking into account the additional commodity brought by bilateral transactions.

This simulation wants to analysis the market development in real time and the analysis of emissions allowances transactions helped to highlight different strategies: stability or taking risk strategy, allowances retention or not, etc. Despite of confirming that emission trading can work and reduce the overall compliance cost, the simulation tool allowed to show that the observed average price of exchanged allowances was 20 % higher than the expected optimum price (IEA, 2001). That reveals the consequences of non-optimum or non-rational behaviours of participants and the resort of this kind of experimental exercise.

ANALYSING THE FUNCTIONING OF A GIVEN SYSTEM

GEST 1 (Baron, 1999)

Greenhouse Gas and Electricity Trading Simulation 1 (GETS 1) took place during eight weeks in 1999 and simulated simultaneously two types of market (electricity CO_2 emissions) and three types of actors (electricity companies, energy consumers and pure traders). Players, who were officials of European electricity companies did not represent countries but virtual power companies (electricity generation and trading), which did not near any resemblance with their parent company.

Each company was defined, for the first session, by an electrical power plant portfolio, a CO_2 emissions quantity and a CO_2 intensity level for power generation. The players had to comply with the given CO_2 emissions limit given under the constraint of answering to a demand curve of electricity. This demand was not played but simulated and sent to each company at the beginning of each session by the "referee" played by the IEA and ParisBourse[SBF] SA. The companies could either invest in new capacities or purchase emissions allowances. As a session lasted one week, the players had time to define their strategies but they have the possibility to trade only once a week, in real time, both CO_2 and electricity trough a dedicated web site during a two-hours session. Trading was well described: while electricity trading was organised as a spot market, CO_2 trading was both spot and "future" contracts market.

Investments constraints have been introduced: new capacities become available only after a certain lead-time (depending on the chosen technology) and capital cost and some features for each technologies have been harmonised in order to avoid technology market distortions. But no financial constraint have been introduced: it was decided that virtual companies would not be assessed on their financial gains but that the aim of the simulation was to learn about emission trading.

Main outcomes of GEST 1

GETS 1 simulation allowed to observe "real" actors reactions trough virtual companies and thus to highlight what could be further behaviours on both electricity and CO_2 market and in the same time the strategies of investment in new capacities. In particularly it has been shown that almost the observed behaviours in electricity trading were reproduced quite closely to what occurs in the "real" world. This point shows that, by reproducing quite real actions, real actors are very interesting in playing such a simulation because they are learning a lot during these 'games' (equivalent as a retribution won by the players).

However, without speaking about some simplified assumptions for simulating electricity market (electricity transport was free, primary energy price remained constant), the simulation was built on strong assumptions on the system design. First only electricity sector was modelled and did not extend beyond this sector in the contrary of the system implemented within Kyoto protocol what probably reduced efficiency gains for the participants. Then the project-based activities (joint implementation or clean development mechanism) were not included. The most difficulty faced by the simulation designers was to find the methodology for controlling their validity in the simulation.

Finally whilst companies were simulated, governments are totally absent of this exercise, although they remain responsible for meeting CO_2 emission objectives. The authors point out that the governments may probably wish to retain some authority on the extra national exchanges of allowances quantities. Despite of this they have chosen to not take this point into account for avoiding more complexity.

GETS 2 simulation (Kieken, 2000)

GETS 2 simulation kept key principles of GETS 1 simulation and wanted to improve the simulation design. First of all, GETS 2 simulation extended beyond the power sector by introducing large energy consumer sectors represented by companies from gas-oil-refining, materials (cement, glass, steel, etc.) chemical and paper industry. All these virtual companies were asked to reduce their greenhouse gas emissions while maximizing their revenues. In the same time, new instruments were introduced such as clean development mechanisms (CDM) and demand side management (DSM) projects, and the electricity and CO_2 markets were developed with new commodities (futures contracts). Finally, in order to test the consequences of allowances allocation method, three simulations were played

This high level of descriptions had two consequences:

- the increase of the exchanges amount needed the building of a new tool for managing the simulation (more than 15 000 transactions were processed). The provided tool was very closed to the trading platforms used for trading worldwide and was provided by a stock exchange operator.
- The simulation allowed to analyse some interactions between both markets but the large data amount made analysing less easy.

In fact, GETS simulations aimed to study more financial and industrial strategies than the feasibility of an emissions trading system. Without speaking about the initial allowances allocation, actors like governments did not entered in the simulation scheme.

ANALYZING THE CONSEQUENCES OF THE SYSTEM DESIGN

BASREC Simulation (Baron, 2002)

BASREC trading simulation mainly differs from the previous ones by making governments enter the game: ten governments and twenty companies simulated the development of a CO_2 emissions trading system combined with an electricity market. The main difference with previous simulations was that players representing governments were asked to choose a method for allocating the emissions target to their national companies and were responsible for the enforcement of their national emission targets by implementing a domestic penalty for not compliance for instance. The governments could purchase CO_2 allowances on the market and were responsible for approval the Joint Implementation projects (as host countries) but could also acquire emission reduction unit (ERU) as donor countries.

Thanks to the design, governments were major elements during this simulation: they were free to define themselves the value of some parameters of the design. It has been shown that few governments have matched their domestic marginal cost of reduction with the international price, because most of them sought to reflect the national priorities (e.g. ambitious domestic reductions). In the same time the government players adopted rather prudent strategies ("no trade is always safer than a bad trade").

GETS 3 Simulation

GETS 3 simulation deeply differed from the previous ones because its aim was not to analyse the functioning of one given system but to analyse the efficiency of several designs according to different characteristics or parameters. Based on GETS 1 & 2 simulations, eight main parameters have been identified and their variations have been modelled. Then variations of these parameters gave 50 simulations of an emission trading system. It was more a modelling experience than an interactive simulation but it allowed evaluating the efficiency of different types of design: no external players were recruited but the previous experiences have been modelled to allow this analysis of sensitivity.

Drawing the features for simulating a white certificates scheme

All these precedent experiences showed us that dynamical simulations can bring interesting lessons for authorities and main actors, what incited to use a similar approach within EWC project. The most important differences between these ETS simulations and the expected work within EWC was that TWC scheme was more a concept than a operational system at the stage where the project begun: three white certificates schemes (France, Italy and United Kingdom) were designed and were running or were going to run in EU. The first reviews of these schemes made by the project partners have shown that large differences exist between these schemes.

The simulation building, described in this paper, was preceded by an interviews campaign in order to identify the typical and alternative white certificates market participants. In the same time, the exchanges we had with these actors helped us to draw the features of further European TWC scheme (EuroWhiteCert WP 4.3, 2007).

Our step was not trying to simulate specifically the existing schemes but, first drawing the features of a TWC market design, then individuating few important parameters (who can obtain TWC, where exchange can take place and with which price rules, etc.) and finally translating TWC system features into simple rules and implementing them as it was done for the different simulations of ETS.

DEFINITION OF SOME FEATURES OF THE VARIOUS MARKET DESIGNS FOR THE DYNAMIC SIMULATION

A white certificates scheme, as market-based instrument, proposes two major compliance alternatives to the obliged parties: either to implement energy efficiency projects or to purchase white certificates by other eligible parties in a direct or indirect way. These alternatives are based upon mechanisms whose time scales are quite different: project implementation takes time whereas purchasing on a market is done in real time. The TWC markets may last for as long as 10 years. We decided to run only the first phase of this new market and that this first commitment period lasts three years (like the first EE&ES Directive period (EE&ES Directive, 2006) or the present phase of the French system). We made the assumption that banking is not possible from this first commitment period to other further phases.

As we had limited resources to simulate white certificates schemes and namely limited time resources, we had to simplify the simulation protocol that has been proposed to the "players" representing actors participating to a white certificate scheme. Furthermore, we had to find compromise and to limit the time taken for playing the simulation by the participants, namely the external participants we invited to join in. We decided to play twelve rounds representing twelve quarters.

SIMULATING THE SUPPLY-SIDE: ELIGIBLE SECTORS, TECHNOLOGIES AND ACTORS

Modelling unit cost of energy savings

Simulating a white certificates scheme needs to rebuild the marginal cost curves of energy efficiency projects for each white certificate supply-side actor (this gives the minimum requested price to generate certificates). For avoiding double counting with EU-ETS, eligible sectors and technologies have to be chosen among the ones, which are not concerned by the ETS. Among the activities included in EWC development, a collection of real case studies was led in order to build a database providing a good representation of what could be the white certificates supply-side (EuroWhiteCert WP 4.2, 2006): non-EU ETS industry, non residential buildings, residential buildings, transportation, networks and grid. The idea was to apply the computation methodology developed by EWC project partners to certify savings and access the real unit cost of savings (including all transaction costs internal to the project). Nevertheless as we wanted to simulate several designs we had to start simulations before the end of the case studies collection and certification, we did not represent all the economic sectors and techniques of the database during our simulations. This is why we made the choice of representing only electricity final consumption of the industrial sector for the two first simulations and then of both the industrial and local authorities for the third round as the database was updated.

Eligibility of energy efficiency projects

In the framework of a real TWC scheme, we can accept two types of eligible technologies:

- <u>standard solutions</u>: TWC market regulators propose a few technologies for which the certification methodology already exists and allows simply the corresponding white certificates issuing. The obliged parties just have to "choose" in these solutions portfolio and present the required proofs;
- <u>non-standard solutions</u>: corresponding certification protocol does not exist. The obliged parties have to present elements to build it and, in this case, the certificates issuing will take more time than for the standard solutions, and a rejection remains possible.

We assumed that, in fact, all standard solutions and the corresponding certification protocol come from negotiations between obliged or eligible companies and TWC market regulators, which take place before the white certificates scheme implementation, and that they are well known by energy providers. Thus they are supposed to use mainly these standard solutions. Non-standard solutions are more demonstrating projects and need time to be sufficiently documented and approved by TWC market regulators. If we consider a three years compliance period, one cannot expect that the flow of "non standard solutions" will be significant. We assume that these projects are more prospective solutions and might become "standard solutions" for the following compliance period (not necessarily for complex schemes). This is why and also for simplicity reasons we decided to implement TWC schemes in which only standard solutions are accepted.

Dynamical features in the supply side representation

Also, in a "real" market, taking a decision or doing an investment takes time and resources: we have to take these parameters into account in our exercise of "a dynamic simulation". Each realization goes with a time for its realization. Our supply-side model gives the quarterly available white certificates potential: the static potential is voluntary limited at each quar-

Table 1: obligations amount by country and by obliged company (cumulated GWh)

Obligations by country (cumulated GWh)

Austria	Bulgaria	Finland	France	Italy	United Kingdom
1 598	734	2 475	12 106	8 578	9 960

Obligations by company (cumulated GWh)

Austria 1	Austria 2	Bulgaria 1	Bulgaria 2	Finland 1	Finland 2
840	758	390	344	1 194	1 281

France 1	France 2	Italy 1	Italy 2	UK 1	UK 2
6 663	5 443	4 278	4 300	5 420	4 540

ter to represent the limited capacity of energy efficiency market for realizing all projects at the same time.

During testing sessions TWC cost decrease due to the effect of energy efficiency projects replication is not considered (the simulated compliance period lasts only 3 years). In case the whole energy saving potential fraction available is not employed during a given market session in the form of white certificates issued, remaining potential for that session is not added to the saving potential fractions available during next market sessions. This rule allows to reproduce what happens in a real market where energy efficiency projects are submitted to the competent authority for certification only in case a demand for certificates exist, not in the absence of demand.

SIMULATING THE DEMAND SIDE: OBLIGED PARTIES, DEFINITION OF TARGETS AND LIABILITY RULES

Several actors for energy efficiency project implementation

Energy efficiency projects come from collaboration between three actors:

- the owner, who takes the decision to invest and has a direct benefit from the improvement;
- the project initiator (obliged or not), who gives the impulsion and helps the owner to take the investment decision;
- the installer or contractor, who realizes the field-work (heating or cooling system specialist, e.g.).

Simulating all eligible actors (and not only obliged actors) would have complicated the simulation work: translating so many actors relationship into equations could not be taken into account within our framework or would have hidden the main facts. Moreover during our interviews with real obliged and eligible actors, we observed that a gentlemen's agreement seems to be set up between obliged actors and contractors, and proposed to the owners. Trough strong partnership, white certificates would go to the obliged parties, as first instigator of energy efficiency project, and thus increase economical activity of their partners installers. Furthermore it seems not very probable that small fitters companies or municipalities, for instance, want to obtain white certificates. The costs associated with white certificates management are discouraging and income opportunities appear low compared with the value of energy efficiency project improvement. This is why smaller companies and municipalities announce they want rather to work with obliged parties in the way of partnership. For all these reasons voluntary actors are not considered as autonomous and the simulations focus only on the obliged actors, who have obviously agreements with the installers.

Note that due to this kind of responsibilities dilution, the obliged actors do not have a full control on the white certificate they are likely to obtain for a given price contrary as for the ETS where the obliged actors mainly act directly on their own patrimony. As they are not the owner of the installations targeted for issuing white certificates, they are dependant on the acceptation of the owners: the obliged parties can just propose an incentive for improving the energy efficiency of an installation and in exchange receiving the corresponding amount of white certificates. This is why, contrary as for the ETS simulation, the players representing obliged parties in a white certificates scheme did not have the supply side modelling tool in their hands, what represented the uncertainty described above.

Obliged parties and associated energy savings targets

During our three simulation sessions we recruited a limited number of participant, to be able to manage rapidly their orders. The aim was to represent several countries and cost disparities in the EU. During the third session (EWC 3), the players represented obliged companies, various in each country: in order to guarantee confidentiality, these companies are virtual, with the main features of the country's utilities but not the specific data of their employer.

A target of energy saving, based on the electricity final consumption of its customers, was imposed to each demand side participant: for the third simulation, these obligations have been calculated first nationally as a cumulated energy saving amount corresponding to 3 % of the national electricity consumptions in the industrial and households/commercial sectors and then shared between both companies of each country. The aim of the game for each participant was to reach the objective at the lowest cost.

Other features

Some other features representing the virtual companies or the countries had also to be defined.

- <u>penalty for non-compliance</u>: one of the most important adjustment levers for public authorities is the amount of the penalties for non-compliance. Based on our curves representing supply-side we decided to fix this amount to 50 euros per MWh missing at the end of the compliance period, as well as the possibility for the obliged parties to get released from their obligation by paying this penalty
- <u>cash flows problems</u>: as the energy saving realization takes time, the mobilization of funds takes time too. The simula-

tion could have considered the capacity for mobilizing funds for each demand-side actor. But we assume that cash flows due to white certificates issuing and trade are not significant comparing to those coming from their business.

- impact on the energy sales and customers loyalty: the realization of energy savings among its customers directly affects the energy sales of an obliged actor (energy provider). On one hand, the energy consumption of their customers is expected to decrease and consequently the income to, but on the other hand, implementing an energy efficiency project with its own customers allows a company to reinforce its relationship and in one way to build and reinforce its business image. Thus we considered that the loss of gross income could be compensated by an increase of the loyalty of the customers within the framework of the development of a privileged relation with the customers: this assumption was leaded by a part from the interviews we have made, but does not make unanimity. The simulation takes this fact into account by giving a bonus: the white certificate cost is decreased by 20 % for an obliged party when it is issued from its customers.
- transaction costs: the costs for looking for white certificates on the field must be represented: for instance doing white certificates with the customers of another supplier will cost more than doing with your own customers. The other transaction costs are already represented in the figures taken from previous work (EWC WP4.2, 2007), which are project-based costs not generic technical costs. For a company, the difference in cost between its (well known) customers and the other suppliers' customers is represented, in the third simulation session, by giving a priority to a company for issuing white certificates with its customers, in such way that the competitors have to make an additional effort for realizing the same thing.

CERTIFICATES' FEATURES AND TRADE

Energy savings unit

We considered that choosing primary energy as energy savings unit would take into account more than energy savings only (i.e. country-specific co-benefits such as carbon emission) and that could increase the difficulty to find a common unit for a EU-wide scheme by introducing several conversion factors for translate kilowatt-hours in carbon ton. This is why we preferred counting white certificates as final energy savings.

The most appropriate mean for counting energy saving is to cumulate energy savings over the lifetime of the technology or measure used to improve energy efficiency. But finding the "correct" lifetime is not an easy task and would become a main task research for further projects.

Type of trade

To trade system types can exist and deeply influence the existence or not of a white certificate's 'colour':

- an anonymous market: in such a market, a demand-side actor buys white certificates without knowing their origin (energy, technology, firm, etc.), that prevents the colouring of white certificates
- "OTC market»: on the other hand, if the demand-side actors can purchase white certificates directly with their owners, and thus, if trade takes place after negotiations between two actors, the colouring become possible.

The existing white certificates schemes show us that certificate trade is not anonymous. First, the acquisition of the certificates is done by bidding. Certificates applicant can pass bidding by public or private way, directly to a particular supplier or by doing a public advertisement. Moreover, as the energy savings realization has some repercussion on the energy sales, the choice of the energy savings measures is not autonomous (i.e. an obliged party may be motivated to implement a project not only due to energy savings realized but also because it will involve switch to an energy it delivers, e.g. boiler reconstruction coupled with fuel switch).

In some cases a small proportion of colouring can be introduced like in the Italian system: the only information available to Italian buyers is the energy sector in which energy savings were realized (three categories have been implemented: "electricity", "gas" and "other energy").

We decided to test both anonymous and non-anonymous systems during our simulations by giving the possibility to choose the origin country of the white certificates during the first simulation session. However if we assume that free trading is allowed by considering that borders do not exist at all and that whoever wants to go to seek white certificate in any country can do it without any constraint, it is extremely probable that most of the white certificates would be created in less efficient countries, what seems to be not politically acceptable by the governments who implement this measure in more efficient countries and would thus finance the implementation of energy efficiency projects mostly abroad but with funds gathered in their country. The Member States will also realize they are loosing the local benefits, the positive externalities of energy savings.

Free market or regulated trading?

Tradable white certificates have very strong local benefits and represent energy bill savings for the citizens: they result in a decrease of the energy loads, and develop energy efficiency supply market, which generates employment and leads to increased comfort and welfare of the citizens and possibly reduces fuel poverty; it's unlikely that political authorities allow international white certificates purchase on a very large scale. In the same way white certificates decrease the need for new energy generation capacity and for grid reinforcement, improve people health by reducing environmental impacts. Thus the white certificates system shows its difference compared with CO_2 emission allowance for instance by not being an negative "externality" of energy consumption and by having local repercussion and local benefit effects. This is why it seems reasonable to imagine white certificate scheme in which some limiting measures are implemented by the governments in order to limit extra international exchanges.

Moreover interviews indicate that potentially obliged party would purchase white certificates on their own customers portfolio in order to retain customer loyalty and build company's image.

Table 2: Summarize of different simulations parameters

Market design features	*EWC 1*	*EWC 2*	*EWC 3*
Supply-side modeling			
Eligible energy	Electricity		
Eligible sector	Industry		Industry & Local authorities
Energy savings	Yearly	Yearly	Cumulated over lifetime
Demand-side modeling			
Obliged parties	Countries		Energy providers
Eligible parties	No voluntary actors		
Liability rules			
Obligations level	~0,2 % of national electricity consumption		3 % of eligible sector electricity consumption
Penalties	50 €/MWh		
Guaranteed minimum price	no		25 % of average market price
Market			
Type of market	OTC (bilateral negotiations)	EU-wide spot market fed by surpluses from eligible parties	EU-wide spot market fed by sale offers from obliged parties

For all these reasons we kept in market design a feature such that that white certificates international trade finds some limits or barriers. In the three tested market designs, we built white certificate schemes in which trade is not made completely easy.

Limiting the white certificates price?

Concerning the introduction of maximum and minimum price of certificates and other relevant parameters in the simulations, the interviews gave us important indications about preferences of contacted companies. However, there is a need for a maximum price to make the game take place (what obliged parties not reaching their objectives have to pay): if the obliged parties can release their obligations by paying a tax (penalty), the maximum price will be the amount of this tax.

Introducing a minimum price guaranteed by the State or by a bank would incite obliged parties to do more than their obligations or eligible parties to come in the white certificate scheme. In fact only a guarantee of white certificates repurchase by the way of a guarantee fund (founded on the basis of widely applied subsidy schemes, for instance) can lead local public authorities (municipalities, etc.) to take part because they are non profit organizations but cannot loose the money they receive from local taxes. We have tested the implementation of such a feature during one of our simulation. The guaranteed price was fixed at 25 % of the average EU-wide market price on the three year in order to avoid it to become a subsidy equal to the energy efficiency project cost.

SUMMARY OF TESTED MARKET DESIGNS

We summarize the main simulated market features during the three simulation sessions in the table below. [1] In the following, this paper deals only with the third simulation (EWC 3).

1. Obligation levels, liability rules: A yearly decrease of 0,2 % of the national electricity consumption is nearly equivalent to a amount of cumulated energy savings corresponding to 9 % of the national yearly electricity consumption over 9 years (as it is mentioned in the EE&ES Directive).

EuroWhiteCert simulation EWC 3

ORGANISATION OF SIMULATED WHITE CERTIFICATES MARKET

According to the assumptions made previously, each player is allowed to realize energy efficiency projects in his own country only (at its own customers or at other energy supplier customers from the same country) and receive the corresponding amount of white certificates. This purchase offer is not subject to a bid, as obliged actors neither compete with other possible eligible actors from their country nor with eligible actors from other countries for certificate assignation. They receive the whole amount of certificates requested, provided that such amount does not exceed the total amount of certificates available at the price offered. If number of certificates requested for energy saving projects implemented at its own customers is below the total certificate amount available, the remaining potential can be assigned by the market operator to the competing obliged company (in the same country) if its purchase offer is sufficiently high. If competing company purchase offer is not sufficiently high, such potential remains unemployed and related white certificates are not generated and made available on the market.

At the same time the players can purchase and sell white certificates in a EU-wide spot market fed by all the surpluses of white certificates from all the participating countries (see further).

During each quarter the obliged parties can make two offers on the EU-wide spot market:

- one purchase offer indicating how many white certificates and at which price they want to buy;
- one sale offer indicating how many of their own white certificates and at which minimum price they are ready to sell. Each player is allowed to sell an amount of white certificate owned not exceeding 10% of its total obligation amount per quarter. This restriction is proposed in order to avoid compliance defaults at the end of the period.

Each round is made up of the following steps:

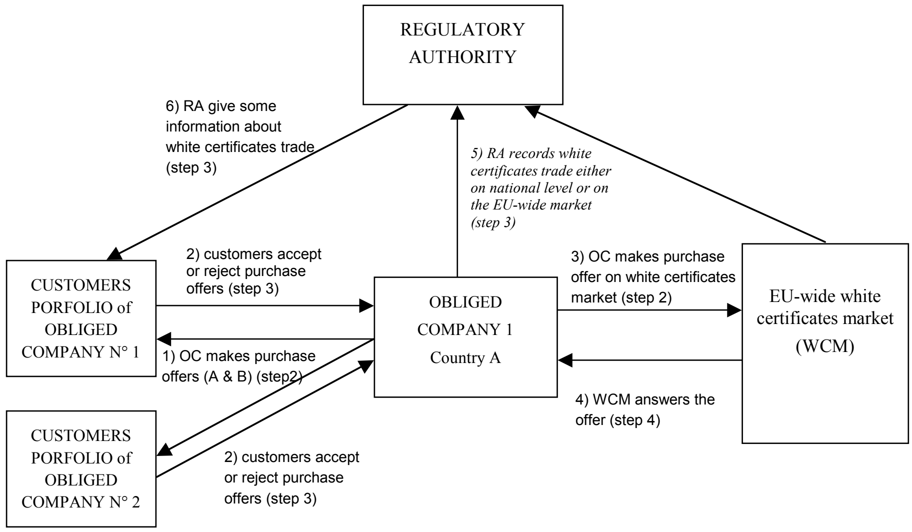

Figure 1: representation of 3rd simulated market design

Step 1: The market operator sends and initial e-mail to all obliged countries participating indicating country obligation and average price of certificates on the spot market.

Step 2: Each obliged company (OC) sends a message to the market operator indicating:

- its energy efficiency project realization at its own customers (cost and maximum expected quantity);
- its energy efficiency project realization at the concurrent company customers (cost and maximum expected quantity);
- its purchase offer on the EU-wide spot market (cost and expected quantity);
- its sale offer on the EU-wide spot market (cost and expected quantity).

Step 3: The market operator deals with project realization and solves the bids on the national and EU-wide Market.

Step 4: The market operator sends a message indicating quantity and price of certificates that the obliged parties have received in the current market session. Moreover, in the mail contents some indications about EU-wide market and the overall amount of issued white certificates are given. Then the players representing obliged actors can send their EE projects realization and purchase offers for the following quarter and the following round begin (back to step 2).

The above figure shows the sequence used for simulating this white certificates scheme and the corresponding steps that were described above (for facilitating understanding, one only country is represented in this figure).

MAIN OUTCOMES AND FIGURES

Obligations compliance

All the companies have reached their obligations (some even largely exceeded obligations) except for the Bulgarian companies:

- Bulgaria 1: this company reached its obligations during the 11th quarter, but resold too many certificates during last quarter. Bulgaria 1 has reached 93,7 % of its obligation amount.
- Bulgaria 2: at the last moment and because of external reasons, the player Bulgaria 2 could not be at office during the two simulation weeks and participated in the simulation only during last quarter. The corresponding results have therefore to be carefully interpreted and are only due to a dysfunction of the simulation.

The total amount of obligations was 35 451 cumulated GWh whilst the total amount of issued white certificates is 36 878 cumulated GWh.

Cost compliance (white certificates cost)

Gross cost incurred by obliged companies to comply with their obligation was defined as the total amount (in euros) spent during the twelve quarters in order to realize energy efficiency projects (and then to receive the corresponding amount of white certificates) and/or purchase white certificates on the EU-wide market.

Net cost was defined as the cost met once penalties and rebuying by the regulator are taken into account as it was described in the rule booklet:

- missing white certificates cost 50 000 euros/GWh (i.e. penalty amount established by the regulator)
- exceeding white certificates are bought by the regulator at the price of 9 220 euros/GWh (guaranteed price is fixed at 25 % of the average market price which resulted in 38 878 euros/GWh)

This net cost represents the real cost for reaching the obligation level in the three years period because white certificates can not be kept for a further compliance period. The average gross cost results in 28 071 euros/GWh, while the average net cost is 29 445 euros/GWh as showed in Figure 2.

Observation and analysis of actors behaviour

One can observe that most of the companies regularly increased their white certificates credit: each quarter they obtained a nearly identical amount of white certificates. These players have planned their EE project realization and/or white

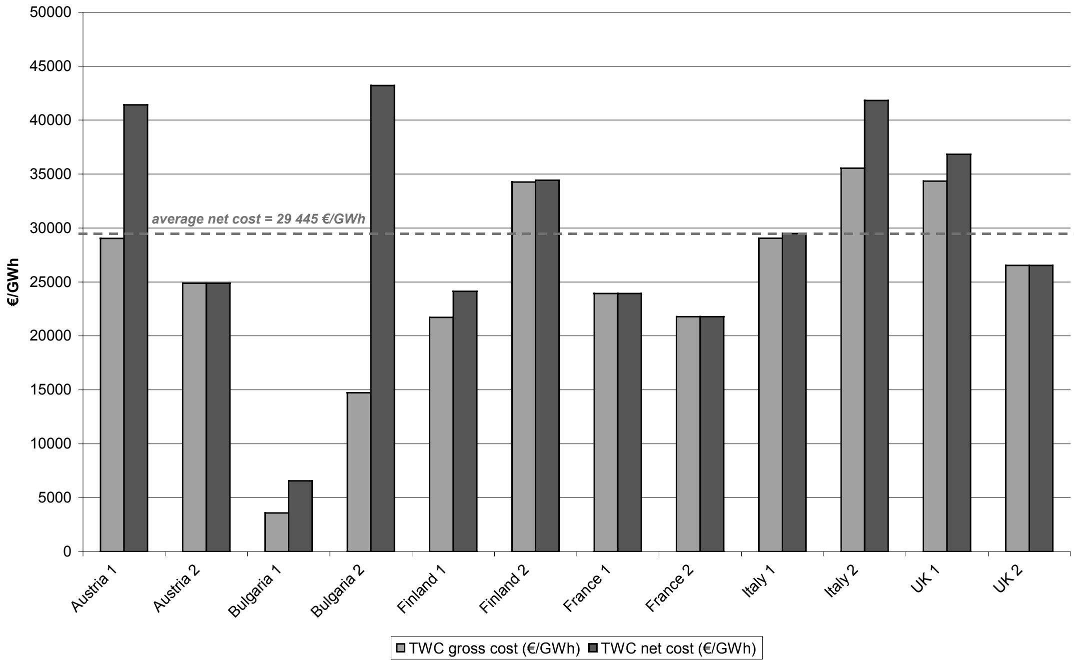

Figure 2: White certificates gross and net costs

certificate purchases and although their marginal cost curve for energy efficiency realizations was initially unknown to them, they attempted to approach to this curve as the simulation proceeded. Most of the players who followed this strategy reached their objectives at a lower cost compared to the other players. Any delay in issuing white certificates become quickly very difficult to be filled up. Indeed, relying on TWC purchase or sale increased the risk of non-reaching the saving objectives and the cost efficiency for getting TWC decreased consequently.

We have to point out that the behaviour on the market by some players remains unexplained. We tried to clarify the reasons behind this behaviour by interviewing such players and asking them the following questions:

- why did they keep buying large amounts of white certificates at a high price on the market although they were receiving at the same time sufficient certificate amounts by realizing energy efficiency project at their customers ?
- why did they realize energy efficiency projects at a high price whilst they could achieve their target choosing lower prices and receiving cheaper white certificates quarter by quarter?

According to players' feedback, we can propose two explanations for understanding these non-rational behaviours:

- something was unclear in the simulation rules and the misunderstanding leaded these players to make wrong choices
- some players have sent orders in advance for the last rounds because they could not participate in each simulation session (as recommended in the rules). For this reason they could not react in time and readjust their orders. This is unfortunately the case for Austria 1, which largely exceeded its objectives and lost much money by buying useless white certificates during the last quarter.

Gap with the marginal costs for energy efficiency project realization

We can build another interesting indicator comparing the net cost for getting TWC met by each company (compliance cost) to their expected average marginal cost for realizing energy efficiency projects at their own customers (see figure 3). This marginal cost represents the optimal white certificates realization cost if the companies could not obtain white certificates either from realizing EE projects at the customers of their concurrent company or from the market, and can be considered as a proxy of their own efficiency in realizing energy efficiency projects.

There are two particular cases: Bulgaria 1 and 2. The first one was alone on the Bulgarian market during almost all the simulation sessions and could realize EE projects with competing company costumers without competing with this company. Thus Bulgaria 1 bought very cheap white certificates (average price: 6 564 euros/GWh). On the opposite side, Bulgaria 2 had to pay a large amount of penalties.

Differences between companies from a same country can be better understood when figure 4 below is considered. As one could expect, the highest cost-efficiency is reached when the company did not purchase on the market and didn't own any white certificates surpluses at the end of the game. For these same companies, the compliance cost remain less than 20 % higher than the expected ones as it was observed for the IEA simulation (IEA, 2001), compliance cost are higher. For the other ones, the differences is well higher (up to 80 %)

Market features

This last figure below shows:

- the exchanged white certificate amounts by quarter
- the market price evolution

We can see that the prices remained almost constant until quarter 10. These prices are quite high because most of the companies which put white certificates on the market tried to valorise

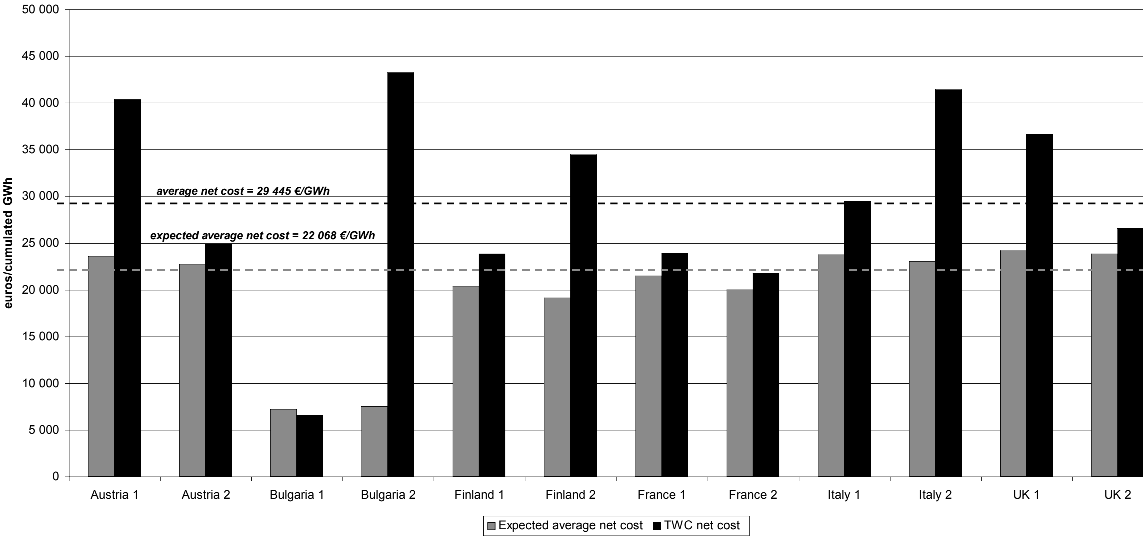

Figure 3: Gaps between expected average white certificate net cost and compliance cost

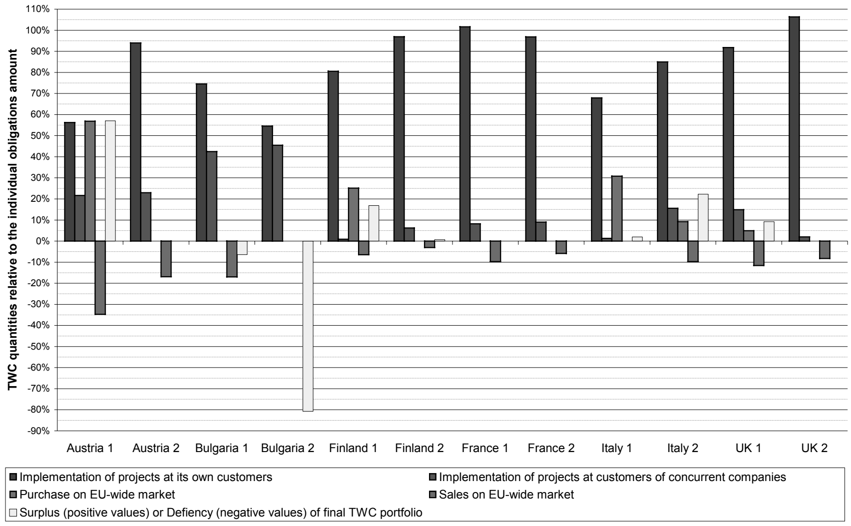

Figure 4: Final white certificate portfolios

them at a very high price (more than 40 000 euros/GWh). This behaviour re-confirms the uncertainty of a compliance strategy that relies on spot market purchase of certificates.

After the 10th quarter the companies owning white certificates surpluses put on the market white certificates at a lower price in order to try to recover anyhow more than they will have recovered thanks to the minimum price guaranteed by the regulator and the market price decreased by 20 %.

The total exchanged white certificates amount is 3 220 cumulated GWh over all the three years. It represents only 8,6 % of the total issued white certificates (36 878 cumulated GWh).

Conclusion

Three designs of EU-wide white certificates markets have been tested. The last scheme design, which was used for EWC 3, was proposed after having taken account the observations made during EWC 1 & 2. In other words, one of the most important outcomes from our three 12-quarters simulations is that building and running several market designs allowed us to reach a better level in describing the interactions between the different actors which are expected to participate in a white certificate scheme, and clarified the mechanisms of white certificates generation. Based on detailed interviews and meetings with possible actors, the description and the modelling we have made identifies many parameters such eligibility of actors, type of trade or existence of a guaranteed minimum price, etc. We succeeded in proposing means for modelling most of them and we made them vary by implementing three different market design.

It is difficult to compare directly the results from these simulations but the last market design that was proposed to real world players, has been recognized by these participants as a realistic view of a future EU-wide white certificates market. It has to be reminded that the aim of these simulations of simplified markets was not to nominate a best design, but to look at different designs, which increased significantly the understanding of interactions between actors. Nevertheless, the EWC simulations allow to drawn recommendations for implementing a EU-wide white certificates scheme.

It should be reminded that we could simulate only one compliance period (12 quarters) without considering a following

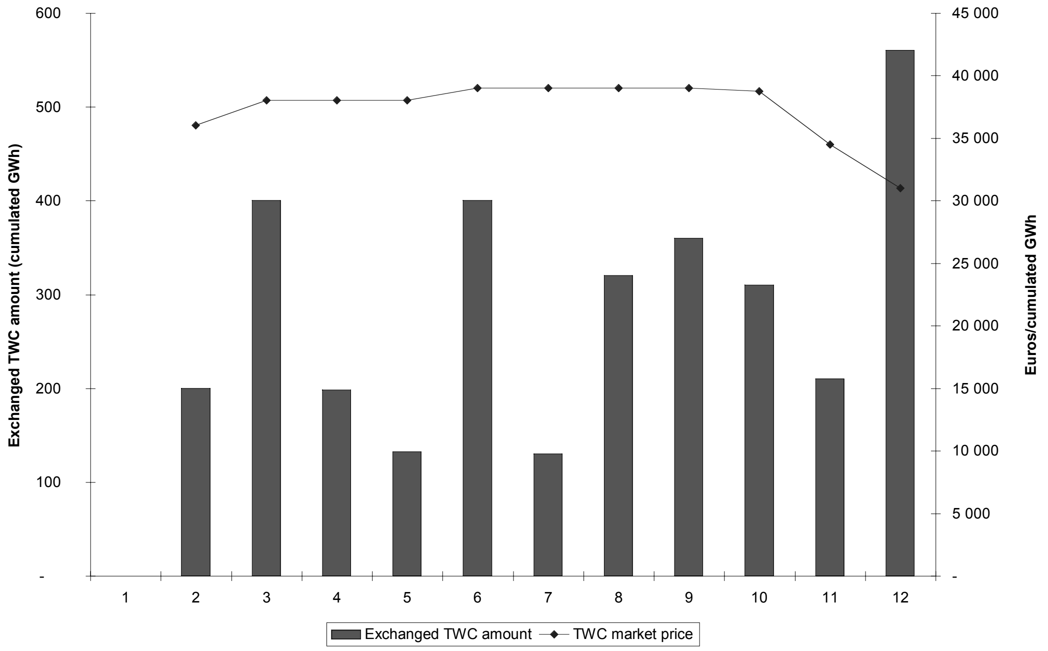

Figure 5 : market price evolution and exchanged quantities

period. This fact has strong consequences on the obliged parties behaviour, namely by making deeply decrease the demand at the end of the compliance period: all white certificates owned after the last adjustment round become "non bankable". This point highlights the consequences of the administrative origin of such a market (as for the ETS): the regulatory authorities really drive the market mainly by fixing the obligation level by defining eligible savings and by defining the rules for further periods.

The introduction of a minimum repurchase price could make the system more reliable by reinforcing the supply-side thanks to the entry of additional actors in the system: local authorities or other non-profit bodies would enter the market and bring some liquidity. We suggest that this minimum price can be guaranteed from subsidies funds, multiplying largely their effect. Without this minimum price the exchanges will be in fact bilateral, taking the form of an order from one obliged party in one country to a quasi subsidiary in a less expensive country.

Whatever the type of market, we recommend to have no illusions about the magnitude of the across borders exchanged quantities: due to the positive externalities of energy savings, countries support energy efficiency projects in their own territory, and the energy providers seem to be interested in preserving first their customers loyalty. Moreover, the market design allowing a TWC stock exchange at the end of each quarter is more favourable to the stimulation of TWC generation than final balancing or OTC bids. In fact, final energy savings have to be seen as a flux that TWC can tap or increase, not as a stock that can be used in one final shot, namely because it demands training, advertising, etc. All this is in favour of a limited but well targeted and quickly changing exchange of TWC between countries, not of a steady and constant frame, like it's the case for ETS.

Due to the diffuse aspect of final energy saving, the evaluation of the available white certificates potential is rather difficult for an obliged party. Furthermore this potential is hidden by the lack of knowledge about the sensitivity of the consumers to the incentives from obliged parties for issuing white certificates. In other words the obliged actors do not have all the levers in hand for implementing energy efficiency projects, which increases the risk of non-implementation of projects and consequently lowers the energy savings amount generated at a given price.

Moreover, note that additionality of EE projects is country dependent and changes rapidly, and that there is a risk of certifying non-additional savings. Besides that, additionality will be a country dependent definition, as well as discounting, and it will be difficult to harmonise fully. So keeping a few simple techniques and harmonizing the methods and values for them (and possibly dropping discounting and additionality in international exchange) may be more manageable for the Member States: this constitutes one condition required for the implementation of a EU-wide white certificates system.

Finally EuroWhiteCert partners would like to thank all the players and external contacts for their assistance for documenting the simulation rules and then to have played the game during the different simulation sessions.

Glossary

ETS: Emission Tradinsg System

EWC: EuroWhiteCert, acronyms for the research project entitled "Stepwise Towards effective European energy efficiency Policy portfolios involving White Certificates", www.eurowhitecert.org

OTC: "Over The Counter"

TWC: Tradable White Certificates

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