RECERT Simulation Activities: First Experiences, First Results and Recommendations

Report of Work Task 2 of the RECERT project

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1. INTRODUCTION

There is currently no robust EU-wide market mechanism that works in harmony with a liberalised energy sector and enables the non-technical integration of all forms of renewables into the energy market. There is a growing interest in Tradable Green Certificate (TGC) systems, both international and at the level of Member States, and RECERT is one of three projects, each different and complementary, that are part-funded by the European Commission's 5th framework programme. The **RECERT project** (Renewable Electricity Certificate Trading project) is focused on electricity sector industrial users, and will disseminate understanding of TGC systems. Co-ordinated development of TGC trading will promote the achievement of the EU's indicative target for renewables penetration of 12% of primary energy by 2010.

A TGC embodies the environmental benefit of renewable electricity production, and interest in TGCs is growing in a number of countries. The environmental benefit is universal, and may therefore be traded separately from the physical power, across national boundaries. Interest in TGCs is proven, and some six countries are already actively discussing TGC trade together, with others involved in independent developments. By adopting this trade, a much larger market for 'green' power is opened and stimulated, the costs and risks of finance are reduced, the acceptability of renewable energy is enhanced, and the cost-effectiveness of new installations are maximised, on an EU-wide basis. Existing work led by innovative EU electricity companies has opened the way to co-operation on TGC development, but this needs to be reinforced to ensure that co-ordination and dissemination reaches as widely as possible in Europe.

The objectives and expected achievements of the project are:

1) to contribute to the aim to get to a co-ordinated TGC market development, and to minimise barriers to TGC trade between Member States and to ensure that information on TGC developments is shared;
2) to disseminate widely, knowledge and understanding of TGC market development to stakeholders and potential beneficiaries;
3) to help key stakeholders in Member States to define the necessary institutional framework, criteria and principles to promote TGC trade, nationally and EU-wide;
4) to analyse the costs and benefits of using TGCs to purchase the environmental benefit of renewable electricity production;
5) to demonstrate to key stakeholders how an EU-wide TGC market could work and to help to develop consensus on how national and international trade in TGCs should be achieved.

2. PLACE OF THE SIMULATION ACTIVITIES IN THE RECERT-PROJECT

The aims of the RECerT project are pursued by four complementary activities. Three of them are the organisation of two sessions of focused workshops in each of the participating countries (EU Member States plus Norway), the organisation of two large international seminars on TGCs and the development and maintenance of a project-related TGC web site. The third and most important one is the development and running of an *internet-based TGC-simulation* activity, with the participation of as many stakeholders from the participating country as possible. In order to be able to make a good design, the simulation has been preceded by a *TGC laboratory trade experiment* at the facilities of the experimental economics laboratory of the University of Amsterdam. Furthermore, the first round of country workshops has been sustained

by playing the *TGC workshop game*, a 30-minute event at each workshop. Experiences from the workshop game might also help in the design of the internet-based simulation.

2.1 The laboratory simulation experiments

ECN (the Netherlands Energy Research Foundation) has been in charge of this first part of the simulation activities together with CREED (Center for Research in Experimental Economics and Political Decision-Making). CREED is a research institute at the University of Amsterdam very familiar with development and use of laboratory experimentation to study economic problems. Experimental economics is a recently developed academic field and its use for the laboratory simulation experiment is pioneering in studying TGC systems. The outline of the experiment seeks to illustrate key TGC market design issues such as the role of issuing bodies, issues of liquidity, expiry and redemption of certificates.

In the experiment subjects (students) have been assigned roles. As the laboratory experiments are linked with the "Workshop game", the experiments are proceeded with only sellers (generators or suppliers) and buyers (suppliers or consumers) in order to get more useful insights and eventually improve somewhat the game itself. (But, in theory, all parties could become traders above their obligation.) The relation between the average price of TGCs on the simulated market and investor behaviour has been simulated by software. The laboratory experiment has been performed during the first two weeks of May.

The focus of the experiment has been on the following key variables of a TGC design.

- How high could (should) be the **penalty** for non-compliance?
- Can one use leftover certificates from one year, for demand in a later year ("**banking**")?
- If you are not able to fulfil your obligation in one year, to what extent are you allowed to catch up in a later year ("**borrowing**")?

Two of these variables (banking and borrowing) could either have a high value or a low value. The level of the penalty had three possibilities. Not all possible 12 combinations have been performed. Some of the most interesting were performed twice. There have been 16 runs in total.

The results of the laboratory experiment have been presented at the national workshops.

2.2 The national workshop game

The central purpose of the national workshops was

1) to introduce stakeholders (players) to the way a European TGC market could work;
2) to create awareness of the possibility and practicality of such a market;
3) to familiarise stakeholders with the use of an internet-based trading environment for TGCs;
4) to illustrate the role and function of a price-setting market place for TGCs;
5) to experiment with the impact of certain variables on the behaviour of the market;
6) to raise the profile of a TGC market in Europe, and to stimulate debate on its pros and cons.

The TGC workshop game functioned as a nice refreshing tool, different from the load of presentations, to get the workshop participants acquainted with the idea of trading environmental benefits. The game was a slightly adapted version of the game that KEMA-Sustainable developed for the introduction of the Green Label system in the Netherlands in early 1998. KEMA Sustainable is a knowledge-intensive organisation active in the field of electric energy systems and environmental technology and management. KEMA-Sustainable's

experience in flexible trading mechanisms for the environment includes the support of the Pilot Programme on Joint Implementation of the Dutch government and the development and management of the Dutch Green Label system.

At each workshop either someone from KEMA or someone from ECN was responsible for carrying out the workshop trading game.

2.3 The internet-based international trading simulation

The internet-based international trading simulation that is under preparation now aims to be ready to begin the simulation in the autumn. The task is led by the exchange and clearing division of the OMEE group (OM Environment Exchange) and mainly assisted by ESD (Energy for Sustainable Development), but also ECN and others. OMEE operates spot, futures and options exchanges in London and Stockholm. The scope of OMEE's services includes consultancy advice on the formation and structure of energy marketplaces, the provision of an integrated systems technology for the operation of energy exchanges and clearinghouses, and the management of exchanges and clearing houses through facilities management services.

The details of the internet-based international simulation game are determined after the laboratory experiments have been analysed. Indeed, these experiments are orchestrated to evaluate key variables for the RECERT internet-based simulation game. OMEE investigates to what extent this can be turned into real trading.

A second round of national workshops will move the mock trading experience into the international arena. The workshops will introduce and 'dry run' the internet-based trading game, which will be run on a web-site. The local partners in RECerT are responsible for recruiting the participants of this second round including the future players of this game. The picture in mind is that one day/week will be the RECerT trading game day, during 4 months or so.

Each participant in the project, plus as many other stakeholders as he can involve, play a 'live' mock trading game over about one week (possibly in two separate runs). Buy and sell offers will be 'posted' on the specially designed website, and deals will be struck automatically. Clearance will be achieved at the end of each trading day, and the day's trading will be reported and explained through the project website. This is then a live experience of what certificate trading could be in the future.

Whilst it is too early to describe the exact form of the game, since this is under development, the heart of the game is a website showing market information for TGCs, specifically offers to buy, offers to sell and trade history (volumes, prices).

3. THE LABORATORY SIMULATION EXPERIMENT

3.1 Starting points

The *first* of two starting points in the simulation is that the government in principle has to give some pressure to ensure that there will be a demand for the TGCs. The main driver is a penalty in the TGC system. Penalties are never high or low per se. It always depends on their relation to the equilibrium price, which is, de facto, merely theoretical. A penalty of 15 Eurocents/kWh is high for a low general RE obligation in a country with lots of potential but is (too) low for an obligation for which only PV is allowed.

Very high penalties give an enormous pressure on buyers, since, if they do not comply, they have to pay a really high fee. Moreover, high penalties may induce higher prices for the certificates. Indeed, although the level of the penalty should not influence the equilibrium price, in practice it will have a price signalling function.

Lower penalties obviously relieve some of the pressure on the buyers. But it seems to make no sense to have a penalty below the equilibrium price. (However, in practice there is a lot of political pressure to keep penalties low.) With very low penalties, sellers would start to offer their units for prices higher than the penalty. This would leave them only with voluntary demand customers. Moreover, a country that might have chosen a penalty price lower than the equilibrium price can not expect much additional capacity installed. Of course, these and other market effects will be affected by the incorporation of other variables in the TGC system such as those mentioned below.

The *second* starting point is that the combination of a varying supply (because of climatic factors and a time lag between investment decisions and actual production start) and a fixed point-demand, will give rise to market problems if there is no flexibility in fulfilling demand: banking or borrowing. From the point of view of compliance in terms of the production of the renewable electricity, policy makers may be inclined to discard borrowing, since they are afraid that it will easily lead to non-compliance. Banking might be more popular, since it is then known that (at least) the desired amount of renewables has been produced.

The possibility of banking can be designed into a system at least in the two different ways:
- having a period of validity that is longer than the year of production;
- allowing an obligatory actor to bank a certain percentage of the certificates with regard to his obligatory demand.

The possibility of borrowing can be regulated at least in the four following ways:
- allowing a certain percentage leeway on fulfilling the obligation (e.g. used in Texas), except, of course, for the last year of the scheme;
- enforcing non-complying actors to buy uncovered certificates at a fixed high price from the TGC-Issuing Body. This Issuing Body will buy the TGCs back from the market for market prices within a certain period (Italy);
- allowing certificates which still have to be produced (to be shown by contracts) to account for compliance for an obligation (one of the options considered in Denmark) whereby the certificates will be redeemed immediately as soon as they are produced;
- applying 'redeemable penalties', i.e. penalties are applied but will be given back when the obliged actor has caught up in the following year (considered in Australia).

3.2 Variable values

The three variables, penalty, banking and borrowing, are varied as follows:

1. The penalty could be *low* (about 0.5 x theoretical price), *medium* (about 1.5 x theoretical price) or *high* (about 4 x theoretical price). With a theoretical equilibrium price of about 6.5 Eurocents/unit this translated to:
   - low = 3 cents
   - medium = 10 cents
   - high = 25 cents.

2. Banking (or validity period which is theoretically similar) could be *high* (unlimited banking/no expiration date) or *low* (no banking/only valid in year of production), which means in the current case no banking or 100% banking.

3. Borrowing could be *low* (no leeway on obligation) or *high* (50% leeway on obligation).

The design was 'incomplete': not all combinations are used; moreover, interesting sessions have been replicated (for the sake of exclusion of curiosities).

3.3 Implementation

For the simulation the relevant energy characteristics of an imaginary EU country was designed. Some of the start assumptions (it is impossible to be exhaustive in the present testimony) for the imaginary EU-country, are:

1. There is an obligation to increase the supply of renewables from 3 TWh in the first year to 6 TWh in the sixth years (appr. 15% growth a year);
2. Every year there is an obligation, leading to the final obligation in the last year;
3. This obligation is equally divided over 4 buyers (buyers with obligation);
4. The obligatory buyers can comply to their obligation by having enough valid certificates on their account by the end of each year;
5. Apart from the obligation there is a voluntary demand, the size of which depends heavily on the TGC-price;
6. The voluntary demand for every year is communicated to and divided equally over two buyers (buyers without an obligation). These buyers are told how many certificates they can cash for how much money at the end of the year;
7. In principle there is sufficient domestic RE potential;
8. The total demand in first year is matched by production of existing capacity;
9. The total electricity consumption is 100 TWh;
10. The equilibrium price is about 6.5 Eurocents/kWh are;
11. In the country six RE technologies can be implemented:
    - Wind near the coast
    - Wind inland
    - Wind offshore
    - Small biomass installations
    - Large biomass installations
    - Grid-connected solar electricity
12. The investor model supposes that investors take their investment decision on basis of expected electricity production price (assumed to be constant at a level of 3 Eurocents/kWh) plus expected average TGC-price over next 15 years.
13. There is a time lag of 1 year between the investment decision and start of production of TGCs. Prices of year 1(2,3,4) determine investments in year 2 (3,4,5), which is added to the existing RE capacity in year 3 (4,5,6), producing TGC according to climatic statistics (if applicable) in that year.
14. The expected TGC-price equals average price of last year, minus a correction for price volatility.
15. The renewables electricity production over a year is not completely predictable because of varying climatic conditions. It becomes only known over the year. Each year is divided in 4 sub-periods.

The subjects did not know the equilibrium price. In theory, traders can have multiple roles, for example, they have obligations and also sell green electricity to consumers. To make the experiment not too difficult to understand for the subjects and to shorten the needed explanation, each subject got a specific role and kept this role during the whole experiment.

Three kinds of traders are in the market.

Buyers with obligations: these buyers receive money at the start of each period. They have to buy a certain number of units before the end of each period (if they do not comply, a penalty is applied). Thus, they spend their money on purchasing units and eventually penalties. They keep the money they still have at the end of the period.

Buyers without obligations: two buyers also receive money at the start of each period. They try to buy units below their redemption value. Their profit is the difference between the redemption values and the prices they paid. Buyers without an obligation get money (less than buyers with obligation) and are told at the beginning of a period that they can TGCeive an X amount of money at the end of the period, for every unit they are able to buy on the market. X = average price of foregoing period + 1 Eurocent. The exact amount is derived from a predetermined demand curve.

Sellers: 6 sellers receive at the beginning of each sub-period units to sell. The money they make by selling these units is their profit.

3.4 Overview of the results

The 25 cents penalty sessions

Session 1, banking and borrowing

No penalties were imposed, only little borrowing occurred (16 units in total). Both buyers and sellers banked, and the prices were very high (up to 20 cents). This resulted in overproduction in the later periods and a crash of the prices.

Session 2, banking but no borrowing

24 penalties were imposed. Both buyers and sellers banked, and the prices were very high (up to 15 cents). This resulted in overproduction in the later periods and a crash of the prices.

Session 3, no banking, borrowing

No penalties were imposed, only little borrowing occurred (22 units in total). Prices are very stable around 7-8 cents, until the last period

Session 4, no banking, no borrowing

27 penalties were imposed (in the first 5 periods). Prices started quite high (9-10 cents), which caused overproduction in the later periods.

Session 5, banking and borrowing, which is the replication of session 1

Due to a software problem, only the data of the first three periods of the market are available. Prices were between 14 and 15 cents, which caused considerable overproduction in later periods (very much like session 1).

Session 6, banking, but no borrowing, which is the replication of session 2

11 penalties were imposed. Both buyers and sellers banked, and the prices were very high (around 18 cents). This resulted in overproduction in the later periods and a crash of the prices (somewhat 'worse' than session 2).

The 3 cents penalty sessions

In all three sessions a lot of penalties were imposed. Typically, units are sold for a little more than 3 cents to buyers without obligations, only if the production was higher than the demand of the buyers without obligation, the buyers with obligations could buy some units, for prices of almost 3 cents.

Session 7, banking, and borrowing

571 penalties are imposed.

Session 8, banking, but no borrowing

753 penalties are imposed.

Session 9, no banking, no borrowing

768 penalties are imposed.

No replication carried out because of the clarity of the outcome.

The 10 cents sessions

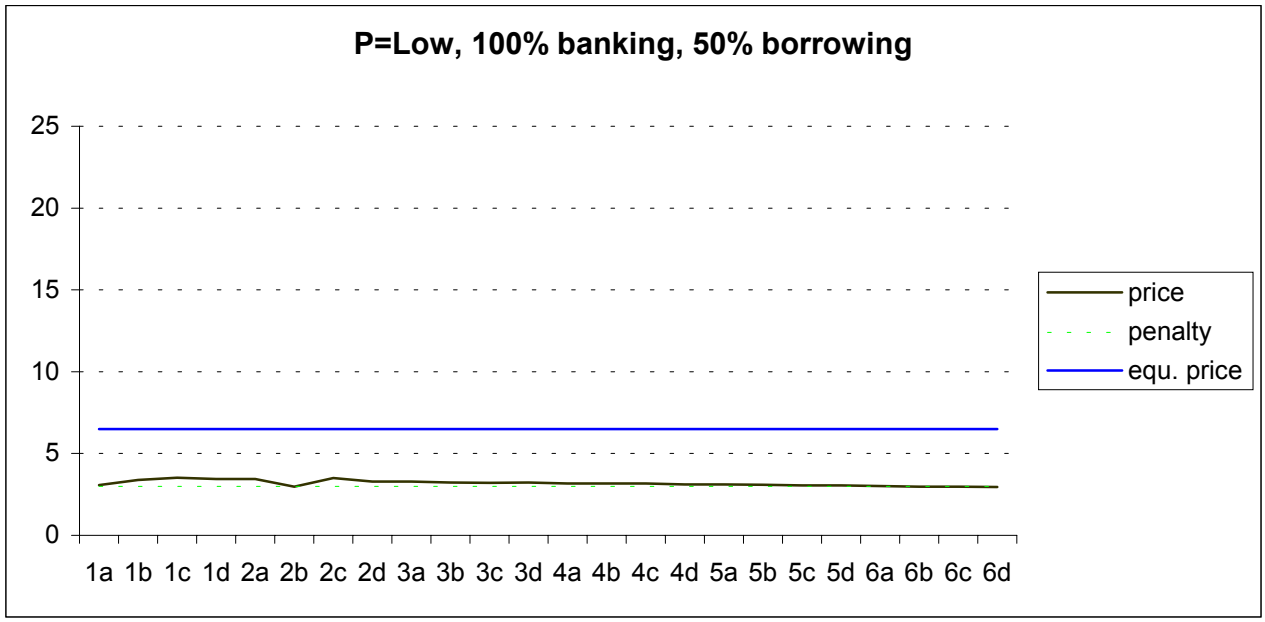
Session 10, no banking, no borrowing
16 penalties (16) are imposed. Prices are very stable around 7-8 cents until the very end. In period 5 some sellers lose some units, probably in an attempt to prevent lower prices.
Session 11, banking, and borrowing
No penalties were imposed, only little borrowing occurred (21 units in total). Both buyers and sellers banked. Prices started around 8 cents and gradually decreased.
Session 12, no banking, borrowing
Subjects borrowed a lot (192 units in total, more than 25%). Only in the final period penalties were imposed (21). Prices are very stable between 5.5 and 6.5 cents.
Session 13, no banking, borrowing, which is a replication of session 12
The remarkable results of session 12 were not replicated. Buyers borrowed less (only 35 units) and part of the production was lost (not sold). This caused high prices in the first 3 periods and overproduction in the later periods. No penalties were imposed.
Session 14, banking, no borrowing
Sellers banked a lot, which caused high prices, close to the level of the penalty (10 cents). In the first three periods 35 penalties were imposed. The high prices caused overproduction and a crash.
Session 15, banking, no borrowing, which is a replication of session 14
In this session both buyers and sellers banked. Prices stayed high up to period 5, in period 6 the prices dropped to 0, but nobody needed units anymore. Only 1 penalty was imposed.
Session 16, banking and borrowing, which is a replication of session 11
No penalties were imposed. A lot of banking by the sellers kept the prices high. Also a lot of borrowing (128 units) was observed. Overproduction in the last period caused a crash of the prices.

3.5 Preliminary conclusions

To set an appropriate penalty, at least a well-founded estimate of the equilibrium price should be made. However, the above given simulation results showed that it is not an easy task. An equilibrium price cannot be known beforehand. (It depends mostly on the real potential of a technology and the real cost-reductions in technology.) The results of the simulation allow drawing some tentative conclusions.

With a very low penalty (about 0,5 x the theoretical price of the certificate), the average price resulted a little bit above the penalty. And because of such low prices, a substantial voluntary market came into view. (Although at these prices only around 2 % of the electricity customers choose for green electricity, this is substantial in a market that starts with a 3% obligation.) The result is that there has been barely any additional capacity installed.
In the case sellers could bank, they did not care too much of not selling all their certificates. They knew they could sell them anyway for 2.99 cent (slightly under the penalty price), and also they can bank the units, so that they might be able to sell them in the following year again on the voluntary market. This meant that in the banking cases the price in all but the last year, was well above penalty price. In several sessions the whole obligatory market has been 'neglected' this way for several years. However, even without banking, penalty application was very high (but, of course, the bill was not), often more than 50% and in some years 100%. This means that the penalty functioned as a tax: nothing happens (there is no compliance) and the penalty is applied.

With a very high-penalty (about 4 x the theoretical price) in the simulation, the prices were not stable and very high in the early periods. There was an enormous pressure on buyers, since, if they did not comply, they had to pay a genuine penalty.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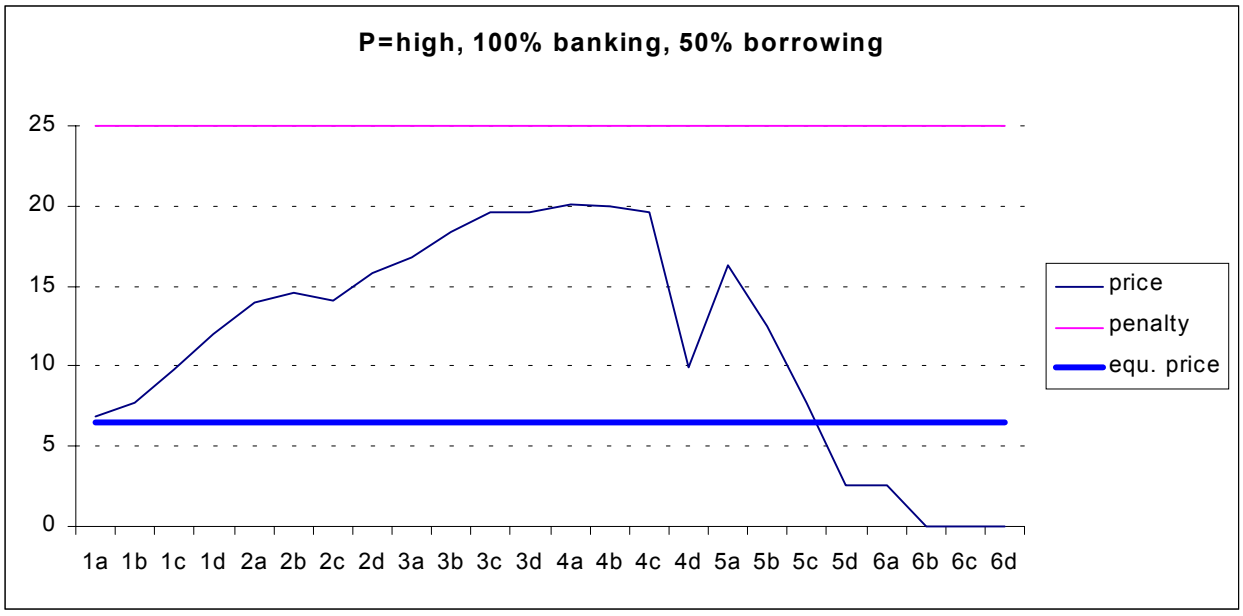
P=high, 100% banking, 50% borrowing
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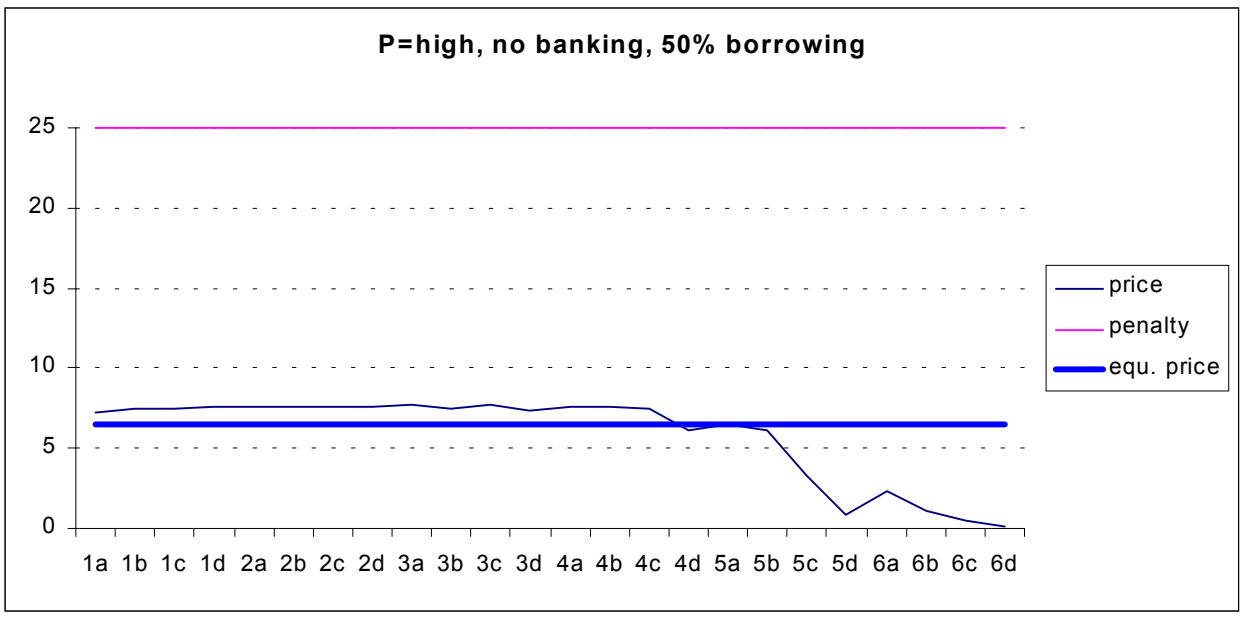
P=high, no banking, 50% borrowing
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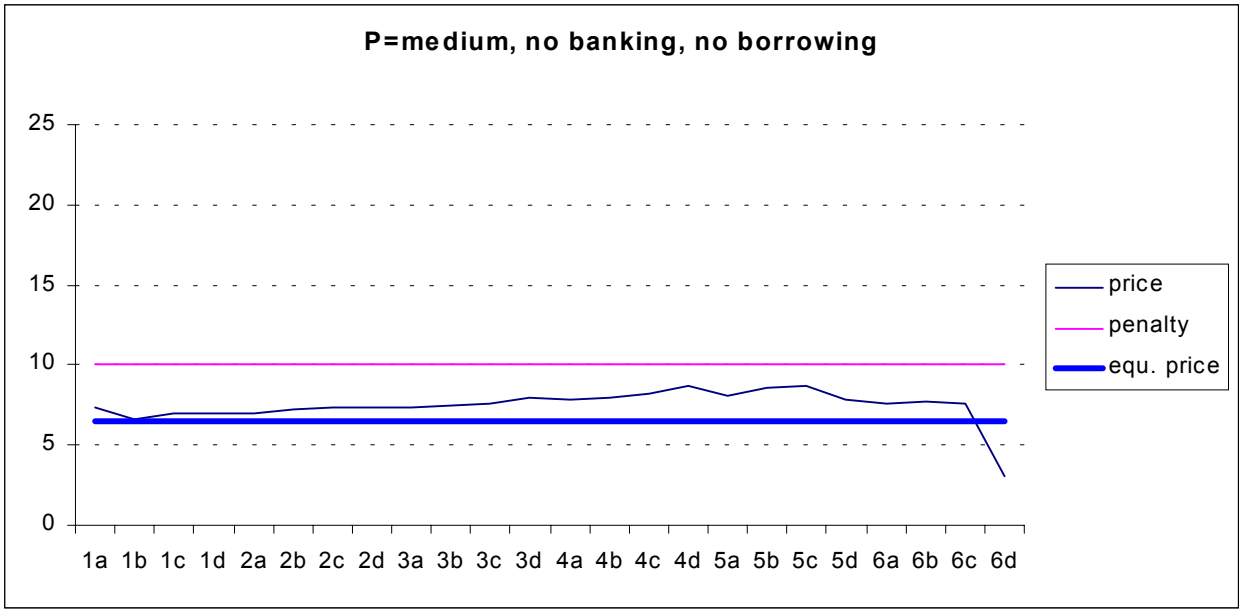

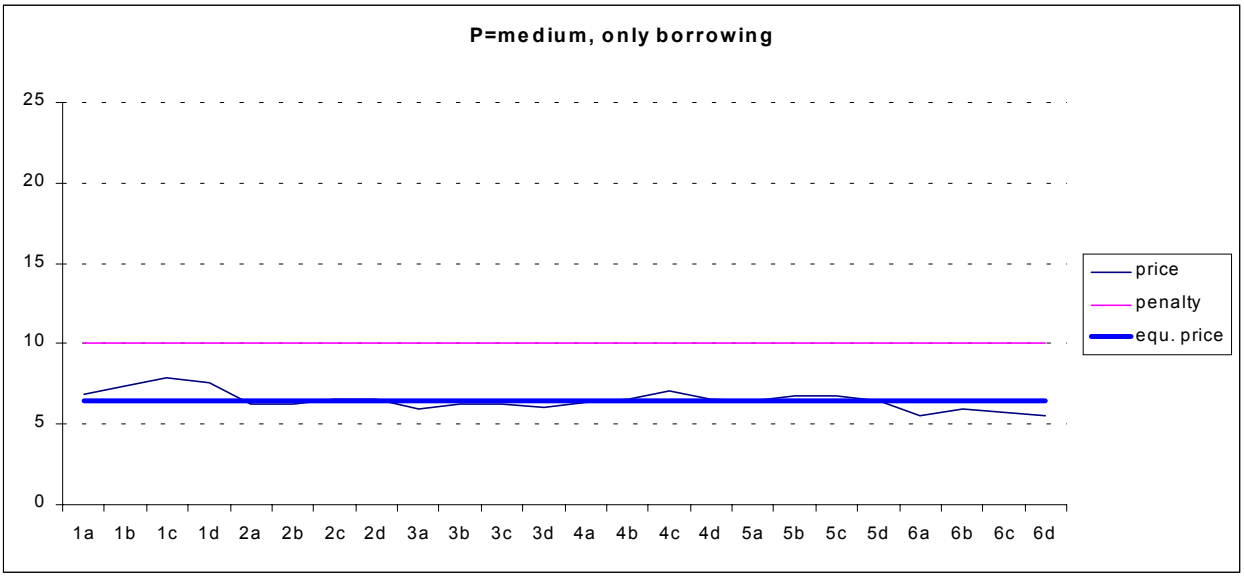

In the simulated cases when sellers could bank, sellers were simply offering the certificates for high prices. If they were not able to sell them all, they banked them, and offered them on the market again in the next year. Since buyers were insecure about how many certificates would be offered on the market next year, they tended to bank too, at least when possible. Both behaviours just mentioned led to an upward pressure on the prices. This caused, after some time delay, an enormous overproduction, understandably followed by a market crash, and thus very low prices in the end. Indeed, one has to realise that with overproduction up to a factor 2 above the obligation in the last year on the market, this would cost at least another 6 years of 15% increase of obligations per year to get at the obligatory demand at the same level.

Finally, when only borrowing was allowed, pressure was relieved from the buyers. No penalties were applied in this case, meaning that everybody always fulfilled his obligation (i.e., full compliance and/or borrowing to some allowed extent). This led to far lower prices, a more stable market and less overproduction (always< 50% with regard to obligation). However, also in this case the average price during the first 4 periods was higher than the equilibrium price, and in the last period the prices went steeply down again.

As the appearance of overproduction may be readily linked to the concept of cost-effectiveness, these simulations showed that TGC systems will not every time be cost-effective. A promotion system for renewables based on TGCs has the potential of enhancing the deployment of renewable energy sources in a cost-efficient way, but its success will depend largely on the way it is designed.

In the design, the level of the penalty is important because it is already a good price signal by itself. Therefore it is interesting to shortly comment on the results of the medium-level penalty cases.

Obviously, a lower penalty (10 cents: about 1,5 x the theoretical price) relieved some of the pressure on the buyers. This medium penalty seemed also to lead consequentially to lower prices for the certificates. However, the nature of the results was not very different from the high-penalty cases. Overproduction still occurred in some cases, when banking was allowed, but less than in high-penalty cases due to lower prices. Unlimited banking had again observable negative effects on TGC-markets. Firstly, it led to high prices, but eventually reduced the value of certificates enormously.

The case with no banking but with borrowing looked as if it was a perfect run, definitely in the sense of being the most cost-effective case because of its constant and low prices. However, this run was replicated, with less superb results. The main difference between the two runs has been the amount of borrowing. In the 'perfect' case, this was at maximum 32% (with regard to the obligatory demand). In the worse case it was at maximum 10%. This means that borrowing can only relieve pressure on buyers if it is really used!

4. THE NATIONAL WORKSHOP GAME

4.1 Purpose of the game

The purpose of this the workshop trading game was to provide a 'hands-on' simulation of trading conditions for TGCs, and to give workshop participants some insight into the decision making and process of such a market. The KEMA TGC trading game had already been played a number of times with different audiences.

4.2 Basic features

The participants in the workshop are divided in two groups:
- sellers of certificates
- buyers.

Each participant receives before the game starts an envelope with:
- rules of the game
- price instructions for his or her role
- set of playing cards
- market information.

When the "market" opens, participants have to find another party to close a deal. In addition to the market information in their envelopes they can follow the price development which is shown on a video screen. The price information on the video screen follows a pre-set price scenario, but the traders have no knowledge about the future occurrence of this price as this

scenario is only shown during the game. Participants have to note the deals they have made on their playing cards. When they have concluded their business, they hand over their cards to one of the organisers to process their transactions. The game is played during about 30 minutes. The organisation analyses these results and determines a winner of the game. Somewhere in the afternoon session of the workshop a short analysis of the game is presented and the winner(s) receive an award.

The ratio buyers/traders is set at 10/18, and the ratio sellers/traders 8/18. There are (more or less) as many certificates offered by sellers as needed by buyers (10 certificates per seller available and 8 certificates needed per buyer). To avoid players to get ready with the game in one deal, a maximum of 4 certificates per deal is imposed.

A maximum price is indicated to buyers and a minimum price to sellers. These maximum and minimum prices are differentiated.

Role	% of participants
Buyer with low maximum price	20
Buyer with high maximum price	35
Seller with low minimum price	30
Seller with high minimum price	15

The figures are indicative. The real distribution differed per time, because of the different sizes of the player group and because of change factors in the process of handing out the envelopes.

Buyers are allowed to buy more certificates then needed for their own demand with the purpose of trying to sell them at higher prices. Also sellers are allowed to buy certificates on the market with the aim to sell them at higher prices. These extra deals had to be noted on so called 'broker cards'.

4.3 Some observations

The fact that the price scenario is preset is not mentioned to the players. This means that the traders often think they have influence on price forming. In practice, they hand over their cards to one of the organisers to process their transactions. Because all trading information is entered as soon as their deals are made, the traders are inclined to imagine such an impact. The result is a lot of fervent buyers and sellers and quite a lively trading floor.

Thus, however simplified the way the games have been played, this kind of simulation still demonstrated participants in RECERT workshops key features of the trade in renewable certificates. They at least have experienced the mechanism of price setting and the role of demand and supply, and the importance of transparency of the market and need for information.

5. DESIGN CONSIDERATIONS FOR THE INTERNET-BASED INTERNATIONAL TRADING SIMULATION

Some lessons for this activity should emanate from a short report that will give examples of the development of tradable economic instruments that are not Tradable Green Certificates (TGCs), but which have similarities to the TGC. Reviewed markets have been agricultural quotas, packaging recovery notes, sulphur oxides emissions quotas and similar. The report will be prepared for the first international workshop / conference that is hold 12-13 October. By putting the TGC developments in the wider context of tradable economic instruments in general, it became easier to understand the behaviour and development of TGC markets.

Experience from trade in other related commodities (such as power and various financial instruments) shows clearly that markets bring the maximum benefit to their users when they have liquidity. High liquidity (i.e., a large volume of trade) leads to transparent, reliable price signals, and helps to give confidence to financial institutions and technology developers who rely on a long-term view in the market to reduce risk and therefore improve access to finance.

Using these results together with the inputs from the above described simulation activities will help to design an internet-based trading simulation. However, because of the large number of variables that could be used, it had turned out to be difficult to simulate in the laboratory the operation of international trade, to subsequently use such specific insights in the context of the internet-based simulation later in the project.

Overall, the internet-based, live on-line TGC trading simulation aims to provide a stimulating experience for participants, which increases their knowledge, progressing in terms of complexity and realism through the three simulation rounds.

While promoting the understanding of this market among potential users and policy makers, answers for at least two specific questions are aimed at. First, what kind of behaviour can be expected of a market characterised by a highly differentiated product satisfying a diversity of demands – i.e., the lessons of complexity versus simplicity? Second, what is the basic practicality of providing a transparent, liquid European market for renewable electricity certificates?

Each certificate will identify the

- country of origin;
- year of commissioning;
- size of subsidy (if any) provided to the generator.;
- type of renewable technology.

Initially, six types of renewables will be included:
1. large hydro
2. on-shore wind
3. ff-shore wind
4. bio-mass (excluding any waste-based schemes)
5. waste certificates,
6. solar certificates.

For the sake of simplicity, geothermal, wave, tidal or other ocean energies are excluded. It should be possible to introduce a 'generic European TGC' contract as well.

The simulation (referred to as ‘RECERT-Sim’) will be built on the characteristics of the sixteen countries in the project. Ten players will be sought from each country (or more), making 160 individual players. The idea is to have four natural sellers (generators), five natural buyers (a variety of these - could be obligated suppliers, green suppliers, large energy users) and one trader in each country.

In each country, a balance of supply and demand may be aimed at. So, for example, if we have virtual generators in the UK who between them have a starting capacity of 10% of current UK capacity, then the virtual suppliers (natural buyers) will have to assume 10% of the foreseen UK obligation. A second option is to impose from the top that the simulation will be based on 5% or 10% of all European green energy supply / demand, and to recruit participants to fulfil these roles. That way we arrive at a balance mimicking the real European situation. However, this

decision will depend on the precise variables that will be set in motion, and therefore on the primary objective of the simulation.

The assorted objectives, players and time scale imply that the RECERT-Sim must be enabled by a full on-line system, giving players direct access to the trading database, and enabling them to execute trades without passing through any third party (i.e., by-passing a telephone interface). Each session comprises three years virtual trading. Each year comprises 30 minutes. Between each year is a 10-minute 'breather'. After each session, the results are reported back to all participants.

Each session is run on a Thursday afternoon, starting at 15:00 CET and finishing at 16:50. From the foregoing simulations, it was learned that there should be a one-year 'trial' (free-for-all) for participants, before the first 'real' session, in order to get the feel of the game.

6. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of the RECERT project

The purpose of energy market liberalisation and the operation of open European markets is to bring greater choice and freedom and lower prices to European energy consumers. The RECERT project is fundamentally about bringing the principles of open market operation and liberalisation to the renewable energy market, and therefore serves the same objective, and brings the same benefits.

The RECERT project is fundamentally an EU-wide activity. (Fourteen EU Member States are represented, plus Norway.) The project aims to achieve European 'added value', by helping to ensure that Renewable Electricity Certificates generated in individual Member States will be tradable between Member States. In turn, this means that renewable electricity developers and generators will have access to a wider market for TGCs. This, in turn, should lead to accelerated investment and a maximisation of cost effectiveness as investments capital flows to the most cost-effective locations in Europe for new renewables development.

There are many factors affecting also the future potential of Renewable Electricity Certificate trading systems which are outside the scope of the RECERT project, such as domestic policies on renewables, tax treatment, and the growth of 'green tariffs' for electricity consumers. RECERT focuses on the key-enabling factor for future TGC trade between and within European countries - namely minimising avoidable barriers to TGC trade between Member States.

Market simulation has therefore been central to the project's philosophy of interactive, hands-on, powerful dissemination techniques which should give key stakeholders real insight and understanding of the issues around TGC market development. The design of a simulation, as undertaken in collaboration with the University of Amsterdam experimental economics laboratory, has been novel. Because this kind of experimental work on TGC markets has not been done before, it has been one of the exciting elements of the project. With this tool, one has been able to experiment with the likely behaviour of a green certificate market in a single Member State, in response to a number of variables such as compliance period and certificate validity, and such as scale of obligation, including the ability to 'bank' and 'borrow' certificates.

The national workshops helped to disseminate knowledge and understanding. They helped to build consensus by conveying an impression of the exciting rate of growth of interest in the concept of Tradable Green Certificates, and the role they could play in the future of renewables in Europe. They have facilitated the co-ordination and development of the simulated European Renewable Electricity Certificate market, by offering the attendants to join the internet-based

international TGC simulation provided by the RECERT project. This will complement among other things the TGCS trial trade and will provide an environment in which one can learn about the likely dynamics of the market, with minimum investment or risk on his/her part.

The results of the internet-based international trading game will give some insight into how Member States are likely to behave in a TGC market place, and what design choices are open to them. The kind of effects that will be investigated will include price instability / fluctuations, achievement of targets, supply of certificates, etc. By trading in this way, renewable electricity developers, financiers, generators, suppliers, and also EU electricity consumers, will gain a greater understanding of renewables demand, supply and market dynamics in a wide range of European regions and countries. In turn, this should help to promote inter-Member State and inter-regional investment and business relationships.

Trading Renewable Energy Certificates (TGCs) is a powerful concept because it works at the interface of finance, technology and consumer interests, and promotes European integration by linking Member States and regions through market activity. It has the potential to help unlock the potential for growth in European renewable electricity production. The novelty in the RECERT proposal is in bringing together Member States with different policies and levels of interest in TGC trading, and helping to build a European-wide market, based on an agreed set of minimum criteria and principles. TGC trade improves the understanding of the availability of RES Europe-wide by giving market actors accurate, timely information on price and availability of renewable energy, and bringing renewables more into the mainstream of energy trading.

6.2 Conclusions with regard to the results of the laboratory experiment

To make sure that new renewable energy will indeed be achieved at a cost-effective way, policy makers have to incorporate with intelligence appropriate variables in the system. The 'devil is in the details', as some say.

Policy makers are often conditioned to the idea of bringing into play a 'penalty'; this also means that they are used to the basic principle of pricing 'non-compliance'. A penalty regime can exploit this principle in two different ways. The level of penalty may be decided on with a deployment goal (i.e., when deployment of new renewable energy is most important) or with a compensation goal (i.e., when a short of supply should not lead to an increased financial risk for the obliged actors).

A low penalty (i.e. lower than the price that is needed to attain the target) may merely function as a tax: nothing happens (there is no compliance) and the penalty is applied. Then, the next issue is to agree on what to do with the penalty money (to put it in RE Funds, to feed it back to the industry), but a discussion of that is beyond the present report. The mere conclusion here is that, all in all, penalties that are too low do not seem to make sense. A switch from the TGC system to a totally voluntary system, or the appliance of a straightforward tax should then be considered.

But, of course, the effect of the variable 'penalty' in the design of a TGC system will depend on the effects of the other variables. The variables can not be appropriate on their own; they also have to fit each variable with each other one. And as said earlier, besides penalty, policy makers should also seriously consider both banking and borrowing as basic features of their TGC-system. However, before considering either banking of the certificates (or, alternatively, the length that the TGC remains valid) or borrowing (thus allowing some leeway in the obligation), policy makers will have to, once again, answer the same kind of question. Will the TGC-system be designed to ensure deployment of new renewable energy, or to reduce financial risk for the obliged actors?

The concept of banking (two forms of it were given in 3.1) seems fairly popular among policy makers, since they know that, at least, the desired amount of renewables will be produced. However, the question should be posed whether proponents of this concept are well aware of most of the odds that may occur. From the results of the laboratory experiment, it appears that banking leads to upward pressure on prices. It gives opportunity to sellers to offer certificates at higher prices, without caring too much of not selling them, at least not in the beginning of the validity period. Somewhat unexpectedly, insecurity of amount of certificates offered seems to have formed an incentive for buyers to 'bank' too.

To allow limited banking (e.g. validity period of 1 year after issuance) would mean to fine-tune the supply, through some effortless adjustment, mostly in order to avoid 'lost' certificates. Unlimited banking has negative effects on TGC-markets as it induces higher prices, and eventually reduces the value of certificates enormously. That is not good for the industry of renewables and its trust in TGC-systems.

Banking could also be seen as an instrument to stabilise the market by way of rising prices when sellers feel these are too low. To enhance the flexibility of suppliers of green certificates to follow demand, it is convenient to use certificates produced in a year of abundant production to fulfil demand in a later, less-abundant year. Therefore, banking is needed or the validity period of the certificate needs to be more than one year. However, it does not need to be eternal; there is a clear trade-off.

We should be aware that the price crash observed in the last period of almost all the experiment sessions is at least partly due to the fact that the experiment ended afterwards. In other words, the certificates had become useless afterwards, and nor banking nor borrowing (which was not allowed in the last period) made sense anymore. In reality this will be different, or at least not happen within six years. This means that the price effects might be less disastrous in reality.

The concept of borrowing, used alternatively or concurrently with banking, looks as if it is far less popular among policy makers, since they are afraid it will easily lead to non-compliance. However, from the results of the laboratory experiment, it appears that restricted borrowing leads to downward pressure on prices, as the 'obligation pressure' on buyers is, to some extent, relieved, whereas still almost full compliance is reached.

How abridged the analysis may be, it suggests readily that borrowing may be seen as an instrument to stabilise the market by way of reducing prices when buyers feel like they are too high.

6.3 Recommendations

These recommendations are based on the laboratory experiment and are valid for the design of the internet-based simulation and TGC schemes in general.

Avoid unlimited banking/ unlimited validity period for certificates
Unlimited banking has unexpected negative effects on TGC-markets. First it will lead to high prices, but finally might reduce the value of certificates enormously. That is not good for the industry and the trust in TGC-systems.

Allow limited banking
The disadvantage of not allowing banking at all is that an oversupply of certificates produced in a certain compliance period will lead to 'lost certificates', i.e. certificates that loose their market value because their period of validity expires. If banking is allowed to a limited extent, this might prevent 'lost certificates', without inducing the negative speculative effects observed in unlimited banking cases. From the experiments there follows no clear-cut answer what the

desired banking regime should be. However, one additional compliance year of validity seems enough to solve the problem of lost certificates.

Be sure penalty is higher than equilibrium price
If the penalty is not higher than the minimum price required to reach the target, the whole system will not work and the penalty will function as a plain tax. However, it should be kept in mind that the equilibrium price couldn't be known beforehand. It depends on the real potential of a technology and the real cost-reductions in technology. To set an appropriate penalty, at least a well-founded estimate of the equilibrium price should be made.

Be sure penalty is not too high
Penalties that are very high do not necessarily lead to higher compliance rates. The experiments show that high penalties can disturb the market very much. The penalty does not need to be higher than 1.5 times the equilibrium price expected.

Allow borrowing
Borrowing certainly relieves the pressure on buyers, and has a strong downward pressure on prices. The experiments showed that if borrowing is only made us of to a rate of 10%, the beneficial effects do not occur. Therefore the leeway allowed should be substantial. In the experiments borrowing was never used at a higher rate than 35% with regard to the obligation, although 50% was allowed. If borrowing is allowed to such an extent, compliance rates are still very good. Penalties do not have to be applied very often, which relieves the administrative burden of the system considerably.