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Interactions of the EU ETS with Green and White Certificate Schemes: Summary Report for Policy Makers

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Executive Summary

This report considers the interactions between the European Union Emissions Trading Scheme ('EU ETS') for carbon dioxide ('CO_2') and trading programmes for renewable electricity generation (tradable green certificates) and for energy savings (tradable white certificates). The study is particularly concerned with the effects that the green and white certificate programmes might have on the EU ETS, although the report provides details as well on impacts of the EU ETS on these other programmes. Note that we do not evaluate the merits of these programmes, but rather consider how the presence of one programme might affect the goals of the others. In addition, in analysing these programmes, benefits unrelated to CO_2 reductions (such as any 'technology forcing effects') are not considered.

These programmes interact in complicated ways, with interactions transmitted through wholesale and retail electricity markets, through markets for the various commodities created by the programmes (i.e., CO_2 allowances, green certificates, and white certificates), and through other markets (e.g., fuel, labour). The following are the major conclusions of the study.

- The presence of green and/or white certificate programmes generally would not affect EU-wide CO_2 emissions from sources covered by the EU ETS although other facets of the EU ETS would be affected. (These conclusions assume competitive markets.)
  - The CO2 allowance price would be reduced.
  - The overall cost of meeting the CO2 cap would be increased (but this comparison does not take into account the non-CO2 benefits of these other programmes).
  - Changes in the location of CO2 allowance purchases/sales due to these other programmes could affect national CO2 emissions (although, as noted, EU-wide emissions from covered sources would not change). However, national emissions reductions through these programmes would not contribute towards meeting Member States' Kyoto commitments as they would be accompanied by increased sale/reduced purchase of CO2 allowances from their participating facilities within the EU ETS.
  - The burden of EU ETS costs and electricity price impacts on different producers and consumers could be affected by the presence of a green or white certificate programme. The effects on a particular group depend upon the many specifics of the programmes, especially on whether the certificate programme is large enough to affect the price of CO_2 allowances, and also on the electricity and certificate market conditions.
- Providing CO_2 credits for green or white certificates would not be desirable, primarily because it would represent double counting and thus undermine the EU ETS CO_2 cap.
- There are some circumstances in which a green or white certificate programme could yield additional EU-wide CO_2 reductions.
  - In theory, the programmes could be so stringent as to reduce CO_2 emissions below the cap, although this is highly unlikely to occur in practice.

  - The presence of the programmes could lead governments to reduce allowances to participating facilities and thus create a lower cap that reflects the impact of these programmes when establishing the total amount of allowances of the Member State's NAP. In this case, the country also would ensure that the expected CO_2 emission reductions count towards its Kyoto commitment.
  - The white certificate programme might reduce emissions from facilities not covered by the EU ETS (e.g., energy efficiency measures that reduce household/commercial fuel use).

§ There are some circumstances in which a green or white certificate programme might lower the cost of meeting the EU ETS CO_2 cap.

  - If retail electricity prices did not fully reflect CO_2 costs (e.g., because of cost-based regulation that excluded opportunity costs or because the allocation process included 'updating'), the retail price effects of green or white certificate programmes *could* compensate for the inadequate price signal.

§ Conclusions regarding the effects of the EU ETS on green certificate programmes are generally similar to the effects in the other direction.

  - The EU ETS generally would not affect the amount of green generation but would decrease the price of green certificates, change the location of green generation, and alter the distributional effects of achieving a green generation target..
  - If the green target were relative (i.e., green generation as a percentage of total generation), reductions in overall electricity demand due to price effects of the EU ETS could decrease somewhat the quantity of green generation.
  - In contrast, if the green certificate programme included a price ceiling, the EU ETS could increase somewhat the quantity of green generation.

§ Conclusions regarding the effects of the EU ETS on white certificate programmes are somewhat different both because of the white certificate programme coverage (beyond sources covered by the EU ETS) and its nature as a credit-based (rather than a cap-and-trade) programme.

  - Electricity price effects of the EU ETS could lead to energy savings that were in addition to savings due to the white certificate programme.
  - Like the green certificate programme, however, the presence of the EU ETS would alter the distributional effects of a white certificate programme.

1. Introduction

The European Union Emissions Trading Scheme ('EU ETS') began on 1 January 2005. The implementation of the EU ETS has raised interest in market-based approaches to achieving environmental and related public policy goals in the EU, particularly those concerned with the promotion of renewable energy and energy efficiency. Indeed, national and regional markets in tradable green certificates ('TGCs') and (to a lesser extent) tradable white certificates ('TWCs') already exist and are receiving increased attention. Green certificate schemes are established or have been proposed in a number of Member States (including Belgium, the Czech Republic, Denmark, France, Italy, the Netherlands, Poland, Sweden and the UK) and form part of a growing portfolio of measures to achieve the renewable targets outlined in Directive 2001/77/EC. White certificate schemes are considerably less widespread, although schemes have been established in Italy and the UK and further activity may be stimulated by the Commission proposal on energy services (COM(2003)739). Both the renewables Directive and the energy services proposal envisage the possible evolution and harmonisation of these instruments into EU-wide certificate schemes.

1.1. Objectives of This Report

With the implementation of the EU ETS, the development of green and white certificate programmes raises some complex issues of policy interaction. The Directorate-General Environment of the European Commission (hereafter, 'EC' or 'the Commission') has sponsored the current study, which has two major objectives:

1. *Analyse interactions among EU ETS and green/white certificate markets.* The first major objective is to describe the interactions between green and white certificate programmes and the EU ETS.
2. *Assess implications of interactions for the policy objectives of the EU ETS.* The second major objective deals with the implications of green/white certificate programmes for the objectives of the EU ETS.

These two major objectives are linked, as insights regarding the interactions among the various schemes provide the basis for judgments regarding the implications of these programmes to the policy objectives of the EU ETS. Note that the study is *not* designed to evaluate the public policy desirability of green/white certificate programmes (or of emissions trading) or to describe their optimum designs—which would require a much wider scope. Instead, the aim is to consider the interaction of certificate programmes with emissions trading.

The major point of intersection of these three policy instruments is in their effects on the electricity market. With this in mind, the current study attempts to do as follows:

- Provide information on the EU ETS and its effects on electricity markets.
- Describe green and white certificate programmes and how they affect electricity markets.
- Evaluate how green and white certificate programmes can interact with the EU ETS.

§ Provide conclusions regarding elements of green/white certificate schemes that might compromise objectives of the EU ETS, and vice versa.

The focus of the current report is tradable certificate programmes. There are of course other support mechanisms for renewable energy sources and for energy efficiency, such as feed-in tariffs or electricity consumption taxes. Evaluations of these of these other policies are beyond the scope of the current study. In some cases the conclusions of the current report would apply to these schemes. For example, any policy that encouraged substantial non-CO_2 emitting generation or major reductions in electricity demand could reduce the price of EU ETS allowances, whether the policy was a certificate programme or some other approach. In other cases, the report's conclusions are specific to certificate programmes. For example, the potential for the EU ETS to lower the cost of certificate programmes would not be relevant for other policy instruments.

1.2. Structure of This Report

This Summary Report for Policy Makers provides an overview of the major effects and interactions among the EU ETS and the green/white certificate programmes. The accompanying Technical Report provides the analytic bases for assessing the effects of the policies and their interactions. The Technical Report also provides additional details of the effects of the policies on different groups (e.g., green electricity producers, electricity consumers).[1]

This report has the following structure. Section 2 provides an overview of the impact of the EU ETS on electricity markets, including effects on wholesale prices, retail prices, and electricity demand. Sections 3 and 4 contain the corresponding analyses for green and white certificate schemes, respectively. The subsequent section provides a summary of the major effects of the green and white certificate programmes on the EU ETS, including overall CO_2 emissions and the costs of achieving the CO_2 targets. The following two sections summarise additional interactions between the EU ETS and the green and white certificate programmes, respectively. The final section provides brief concluding remarks.

[1] We use the terms 'consumers' and 'end-users' interchangeably, and these may be households or other users. We use the term 'supplier' to refer to the entity from which end-users purchase electricity (sometimes referred to as 'distribution' or 'retail electricity' companies), and these are therefore different from 'generators' or 'electricity producers', who sell electricity in the wholesale market. Of course, many markets include vertically integrated companies that both generate and supply electricity.

2. EU ETS and Effects on Electricity Markets

The European Union Emissions Trading Scheme ('EU ETS', or 'the Scheme') was established by the Emissions Trading Directive (2003/87/EC, subsequently 'EU ETS Directive') of the European Parliament and of the Council of Ministers in 2003. The Scheme was adopted as a cost-effective means of complying with the EU's commitment under the Kyoto Protocol to reduce its emissions of greenhouse gases ('GHGs') in 2008-2012 by eight percent relative to 1990 levels. The EU ETS is organised into phases: the first phase runs from 2005-07 and the second phase from 2008-12, coinciding with the first Commitment Period under the Kyoto Protocol.

The EU ETS is a cap-and-trade programme. The rules in the Directive determine the type of installations to be covered, outline the general criteria for allocating emissions allowances to the various installations, and stipulate an obligation on each covered installation to surrender allowances equal to its total emissions in each calendar year.[2] Member States are given considerable discretion to implement these rules. The allocation of allowances to installations must be set by Member States in their National Allocation Plan ('NAP'), which requires approval of the Commission. Allowances are tradable, and thus participants whose emissions are lower than their allocation have surplus allowances that they can sell to other installations that want to purchase allowances.

In addition to allowances allocated by each Member State to individual installations, allowances may also enter the Scheme through the 'linking Directive' (COM 2003/403), which allows emissions credits generated through the Flexible Mechanisms of the Kyoto Protocol to be valid for compliance within the EU ETS.[3]

This section discusses the effects of the EU ETS and associated CO2 allowances on electricity markets in the short- and long-term (section 2.2). It also discusses the implications of various 'real-world' complications in the relevant markets (section 2.3). The final section (section 2.4) summarises the key points covered.

2.1. The CO_2 Allowance Market

The EU ETS caps emissions of CO_2 from covered installations and establishes a market for CO_2 allowances. Provided there is full enforcement of obligations, emissions will not exceed the amount corresponding to the total number of allowances issued (plus any brought in via the Linking Directive). As will be discussed below, this has important implications for the effects of other policies, including green and white certificate programmes. The market for CO_2 allowances means that CO_2 emissions represent a cost of doing business, as participants have the opportunity to sell allowances that they do not require if they do not produce emissions. (This circumstance gives rise to the concept of the 'opportunity cost' of CO_2 emissions).

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[2] Under the EU ETS, each 'allowance' or 'EUA' corresponds to one tonne of CO_2 emissions.

[3] Eligible Flexible Mechanisms include Joint Implementation ('JI') and the Clean Development Mechanism ('CDM').

The price of CO_2 allowances is ultimately determined by the stringency of the cap on emissions and the cost of reducing emissions to that level. Empirical studies have found that the cost per tonne of emissions abatement ('the marginal cost of abatement') increases as the level of emissions decreases, because progressively more expensive emissions reductions measures must be undertaken. With a stricter emissions limit, the allowance price would therefore be higher. Similarly, if higher levels of goods production (e.g., because of higher economic growth) result in more emissions, then more reduction measures must be undertaken, and so the price of allowances would increase.

2.2. Impacts of the EU ETS on Electricity Markets

This section considers the effects of the EU ETS on electricity markets. We begin with effects under competitive conditions, first in the short-term and then in the long-term. We then consider the implications of complications that may arise in practice. These complications may change the way the EU ETS affects wholesale and retail electricity prices.

2.2.1. Short-term impacts of the EU ETS on electricity prices

In competitive electricity markets, wholesale prices are determined by the level of demand and the cost of providing electricity. In the short-run, the level of demand can generally be taken to be fixed (that is, it will not be affected by the price). The relevant cost is the *marginal cost*, which is the additional cost of the last unit of electricity produced. In competitive markets, wholesale prices are determined by the marginal cost of the *marginal producer*, the last generator required to meet demand. Prices cannot be lower, as the generator otherwise would not find it profitable to generate and demand would not be met. Conversely, competition would serve to bid down prices if they were higher than the marginal cost.

The introduction of the EU ETS increases the marginal cost of all electricity generation that produces CO_2 emissions. Generators will react to the market for CO_2 emissions by making efforts to reduce CO_2 emissions from their units—such as switching to lower-CO_2 sources or increasing efficiency—as long as the marginal abatement cost of these efforts is less than the CO_2 price. These abatement costs will affect the cost of providing electricity. In addition, the generators will incur costs for the residual CO_2 emissions that remain after the cost-effective abatement options are exhausted, and which they therefore have to offset by allowances obtained initially or purchased in the market.

Even if generators receive sufficient allowances 'for free' under their NAP to cover their residual emissions, every tonne of CO_2 emitted still results in a cost (an 'opportunity cost') because the allowance used to cover each tonne of CO_2 emitted could otherwise be sold at the market price. This means that it is optimal for generators to include the *opportunity cost* of CO_2 emissions in their costs, regardless of how allowances were originally awarded.

In the competitive case, wholesale prices would increase by an amount equal to the increase in cost for the marginal producer. The size of this increase in turn depends on the *CO_2-intensity* of production of the relevant unit (i.e., the amount of CO_2 emitted for each megawatt hour (MWh) of electricity produced) as well as the price of allowances. For example, a modern coal-fired power station may have a CO_2-intensity 2.5 times that of a modern gas-

fired plant, while some forms of generation (e.g., hydro power, wind power) emit no CO_2 and so have a zero CO_2-intensity. This means that the added cost per MWh due to CO_2 emissions differs by fuel—the cost of coal-fired generation increases more than that of gas-fired generation for a given CO_2 allowance price.

Even in a fully competitive setting, the electricity price impact of the EU ETS will differ between EU Member States, because the CO_2-intensity of marginal producers in national markets varies. Moreover, interconnections among systems may mean that effects in any one Member State depend not only on conditions in the national electricity market, but also on conditions in those other countries with which it is interconnected. If imported electricity is on the margin, then the characteristics of the marginal producer in the exporting country will determine prices.[4]

As a further complication, the nature of the marginal producer of a given market may change in response to CO_2 costs. A sufficiently high allowance price may cause the price of higher-emitting units (e.g., coal-fired) to exceed that of low-emitting units (e.g., gas-fired), where prior to the EU ETS the low emitter had a higher marginal cost of production. Such a shift in the marginal fuel would imply a larger impact of the EU ETS on the electricity price than if the low-emitting technology had stayed on the margin, as the resulting marginal producer has a higher CO_2-intensity. Conversely, where high-emitting generation was on the margin prior to the introduction of the Scheme, the result may be a switch to a marginal technology with lower emissions intensity. The impact of the EU ETS would then be smaller than it would have been if the high-emitting technology had stayed on the margin. More generally, the net impact of the EU ETS is the difference between the marginal cost (*excluding* CO_2 costs) of the marginal technology *before* the Scheme is introduced, and the marginal cost (*including* CO_2 costs) of the marginal technology *after* the introduction of the Scheme.

In a competitive setting, increased costs in the wholesale market have a direct impact on the retail market for electricity. Higher wholesale prices lead to higher costs for retail suppliers (which are consumers in the wholesale markets), so suppliers would increase prices in the retail market to reflect the increased costs. As discussed below, a number of complications may arise in practice that can alter the relationship between wholesale and retail prices.

2.2.2. Long-term Impacts of the EU ETS on Electricity Markets

The EU ETS has an immediate impact on short-run electricity markets. However, there are a number of effects that tend to occur in the longer-term, including the addition of new generating capacity and effects on electricity demand.

In the long-run, new generation capacity will be added to meet electricity demand growth or replace any retiring plants. In competitive markets, long-term wholesale prices reflect the long-term costs of new entrant producers. In the absence of allocations to new entrants, long-term costs include the cost of CO_2 allowances and the EU ETS therefore affects the relative competitiveness of low- and high-emitting potential new sources. For example, depending on

[4] If generators in interconnected countries are not part of the EU ETS and do not face CO_2 constraints, then domestic producers could become less competitive, although for the vast majority of Member States this will not be a concern.

expected CO2 prices, the addition of some new nuclear or renewable capacity may yield a higher expected return on investment than fossil fuel generation with the EU ETS, even though this would not be the case without a price on CO_2 emissions. More generally, sufficiently high allowance prices make the entry of low-emitting producers more likely.

The higher retail prices induced by the EU ETS will tend to lead to longer-term reductions in electricity demand. For example, previously uneconomical energy savings may be undertaken when prices rise, or consumers may change their consumption patterns. Put differently, such reductions in electricity consumption are among the long-term CO_2 emissions abatement options.

The decrease in demand in turn affects non-CO_2 costs of wholesale generators. This is because a lower level of electricity production generally corresponds to a lower-cost marginal producer, with resulting lower wholesale electricity costs net of CO_2-costs.

2.2.3. Complications in 'Real-World' Electricity Markets

The analyses above abstract from some of the complications that can alter the effects of the EU ETS on electricity prices. The following are brief summaries of these additional considerations.

- *Fluctuations in electricity demand.* The stylised electricity market characterisation presented above assumes that there is a single 'marginal' technology (e.g., natural gas) at all times. In fact, the marginal unit can change by hour of the day (e.g., peak versus off-peak) and day during the year (e.g., weekday versus weekend, summer versus winter). In many parts of the EU, coal or some other fuel or technology (and not gas) is the marginal unit at many times of the day.
- *Allowance allocation method.* Under certain methods of allowance allocation, electricity generators will not reflect the full cost of CO_2 allowances in their costs (and thus in the price of electricity). For example, if future allocations are influenced by current emissions (an 'updating' approach), generators have some incentive to increase output, which can offset to some extent the opportunity costs of emitting CO_2. Similarly, providing allowances to new entrants may cause long-term electricity prices not fully to incorporate CO_2 costs. Confiscating allowances from facilities that close also may affect prices and the composition of generation by keeping open plant that otherwise would have closed.
- *International trade in electricity.* If domestic generators face competition from foreign sources of electricity, the introduction of CO_2 costs can make domestic generators less competitive with foreign sources (e.g., if foreign sources have lower-emitting technologies on the margin). This is particularly the case if foreign sources are not subject to CO_2 constraints (although that circumstance is unlikely in the EU).
- *Market power.* If individual market participants have some control over the price of electricity this may affect the degree to which the costs of CO_2 are passed on to consumers. Generators with market power might react to higher costs by price increases that are either greater or lesser than if the market were perfectly competitive.

- *Electricity regulation.* While the above analyses assume that all electricity markets are liberalised, several markets in the EU remain regulated. Under regulated regimes, the extent of price increases will depend on regulators' treatment of CO_2 costs, particularly the opportunity costs of emissions when allowances are provided for free.
- *Long-term contracts.* Much electricity is sold via long-term contracts and this can delay the effects of CO_2 costs on market prices. However, these delays are likely to be of short duration.
- *Fuel market effects.* In both the short- and long-term, the EU ETS may affect the demand for different types of fuels. The most likely effects are an increase in the demand for natural gas and a decrease in the demand for coal. These demand changes can, in turn, affect prices, serving to offset some of the cost advantages of natural gas relative to coal. The effect would depend both on the significance of the EU as a consumers of fuels and on the marginal source of gas supplies.

Some of the 'real world' effects outlined above can affect the objectives of the EU ETS to minimise the cost of meeting the CO_2 cap that is set. In particular, mechanisms (such as cost-based regulation) that prevent the opportunity costs of CO_2 emissions from being reflected in retail electricity prices will interfere with the aim of the EU ETS to effect cost-effective reduction of CO_2 emissions. This is because some abatement measures that would be undertaken in the competitive case may no longer be incentivised; for example, fuel switching, energy saving, or substitution of grid electricity for other energy sources (e.g., combined heat and power generation) may only be economic when electricity prices are sufficiently high. For a given cap on CO_2 emissions, other, more expensive abatement measures would have to be undertaken in their stead, increasing the total cost of meeting the cap.

To the extent that the cost-effective set of emissions abatement measures include a greater amount of electricity generation from renewable energy sources and end-user energy efficiency measures, factors that restrict the full pass-through of CO_2 opportunity costs also reduce the contributions of the EU ETS to increasing renewable generation and energy efficiency. Such restrictions therefore tend to increase pressures to develop separate certificate schemes to attain desired levels of renewable generation / energy savings.

2.3. Summary

Table 2.1 summarises the impacts of the EU ETS on key variables in electricity markets. Note that the effects listed for renewable generation and energy efficiency only include the effects of the EU ETS, implicitly assuming no green and white certificate schemes are in place.

Table 2.1
Summary Impact of the EU ETS on Key Variables

Variable	Effect of EU ETS	Comments
Wholesale electricity price	Increased	The EU ETS introduces an opportunity cost for CO_2 emissions. This in turn results in a higher marginal cost of electricity production for CO_2-emitting generation. The increase in generation costs results in higher wholesale electricity prices. The extent of the price rise depends on the CO_2-intensity of the marginal producer, i.e., the most expensive producer to meet demand. These effects could be reduced by an 'updating' allocation method.
Retail electricity price	Increased	Retail prices increase as wholesale price increases are passed-through to end-users. These effects may be reduced by electricity rate regulation or in situations of imperfect competition.
Electricity demand	Reduced	Higher retail prices lead to a reduction in electricity demand, although effects may be small in the short term.
Non-green generation	Reduced	Total 'non-green' generation decreases both because of an overall decrease in electricity demand, and because new investment in green generation may become more profitable.
Green generation	Likely Increased	The proportion of renewable generation is likely to rise, as higher wholesale prices with no additional costs create additional incentives for renewable generation. However, these effects may be offset by reductions in electricity demand. The outcome depends on the situation of existing renewables in the electricity generation merit order.
CO_2 emissions	Reduced	CO_2 emissions decrease as compliance with the enforcement of the EU ETS emissions cap.
Investment in conventional generating capacity	Varies	Lower demand may lead to less need for new investment. Free allocations to new entrants may lower the wholesale electricity price at which entry starts to occur. Conversely, confiscation of allowances upon shutdown may delay exit, and hence cause new entry to be postponed.
Investment in end-user energy efficiency	Increased	Investment in energy efficiency increases as the retail price of electricity increases.
Investment in new renewables	Increased	Higher wholesale electricity prices but unchanged costs of renewables generation help make investment in new renewables more attractive increase. More generally, the relative competitive position of low-emitting generation technologies is improved.

3. Tradable Green Certificate Schemes and Effects on Electricity Markets

The EU has set the aim of increasing the Community-wide electricity share of generation from renewable energy sources to 21 percent by 2010 as part of an overall target of 12 percent of gross national energy consumption from renewable energy sources by 2010. To this end, Member States have set national indicative targets for the share of renewable electricity of total electricity consumption based on the reference values in the Directive 2001/77/EC. In addition to this EU-wide policy, many Member States have separate targets and objectives to increase the long-term share of the national electricity generation from renewable energy sources. Objectives noted for these policies include the safeguarding of electricity supply, reducing CO_2 emissions, reducing local pollution, stimulating innovation and technology development, and supporting domestic industry.

A number of Member States have developed Tradable Green Certificate ('TGC') schemes to achieve these aims. These schemes typically establish requirements to produce/deliver a certain percentage of electricity using renewable and other 'green' sources. Compliance is demonstrated by surrendering green certificates, which are a record certifying the production of a certain quantity of electricity from eligible (i.e., 'green') sources. The details of the programmes can differ considerably; for example, programmes might classify 'green' differently by including or excluding certain generation technologies. Most schemes aim only to include installations that would not be commercially viable without further support, and thus exclude some renewables such as large-scale hydro power and some pre-existing other renewable installations. Conversely, some schemes include energy sources that are not strictly 'renewable,' such as fossil fuel-fired combined heat and power ('CHP') generation.

The purpose of establishing the certificate market is to introduce an element of competition between green producers and thereby help ensure that a given green quota is met in the most cost-effective manner. With a TGC programme in place, electricity generation from green sources produces two distinct commodities: (1) electricity, which is sold in the normal electricity market; and (2) green certificates, which are traded in a green certificate market.

This section discusses green certificate programmes and their interactions with electricity markets. As above, a summary section (section 3.3) outlines the key points from this discussion.

3.1. The Green Certificate Market

Many green generating facilities would not be cost-competitive with more traditional sources of power in the absence of special support. In many circumstances, such support is offered to compensate for the perceived external costs of conventional generation technologies. This means that the (long-term) marginal cost of new green capacity is higher than the (long-term) wholesale electricity price. In a TGC scheme, this difference between the wholesale price and the cost of green generation (the 'green cost gap') is made up by the support offered by certificates. Specifically, under competitive conditions, the price of certificates would be equal to the green cost gap of the green generator that supplied the 'final' unit of electricity to meet demand under the green quota (i.e., the marginal green producer). This price is set as in

other competitive markets: certificate prices cannot be below the green cost gap of the marginal green producer, as then producers would be unwilling to meet demand, while prices higher than the cost gap would be bid down as suppliers of certificates compete in the certificate market.

One consequence of this system is that certificate prices are 'self-adjusting' and kept at the minimum level necessary to achieve the required level of green generation. For example, higher electricity prices would result in a lower green cost gap, which would enable green producers to offer certificates at a lower price. More generally, in an unimpeded green certificate market, prices would be negatively correlated with anything that increases wholesale electricity prices without affecting the cost of green generation. For example, if higher natural gas prices caused wholesale electricity prices to increase, then the price of certificates would be expected to fall.

In most schemes, the amount of green generation is set by the green quota. Additional measures promoting green generation (such as tax exemptions, investment subsidies, or any other measures affecting the marginal cost of generation from sources covered by the TGC scheme) therefore would not increase the *total amount* of green generation. However, if these measures lower the marginal cost of green generation they may lead to lower certificate prices. As will be discussed below, the EU ETS may also have this effect on the green certificate market.

3.2. Impacts of TGC Schemes on Electricity Markets

As with the EU ETS, it is useful to consider the basic impacts of a TGC scheme on the electricity market, and then consider 'real world' complications.

3.2.1. Electricity market impacts of TGC schemes

Because green generation technologies have higher costs, their use will increase the total cost of generating a *given amount* of electricity as compared to the case of using conventional 'non-green' sources. (Note that we do not consider the benefits of green certificate programmes.) Under a typical TGC programme, retail providers have to supply a set percentage of electricity from green sources. The TGC scheme therefore acts as an effective 'tax' on their purchases of electricity in the wholesale market, with the tax equal to the certificate price times the percentage requirement. One effect of the certificate programme is therefore to exert an upward pressure on retail electricity prices.

Another effect of the TGC scheme is to restrict the share of electricity demand available to producers of conventional (or 'non-green') electricity. For example, a ten percent quota implies that only ninety percent of total demand is available to these generators. In the short-run (specifically, for a given installed capacity) this has the effect of *lowering* wholesale electricity prices, since lower demand generally is associated with a lower-cost marginal generating unit. (Electricity prices would still be set by the cost of conventional generation.) In the long-run, however, wholesale electricity prices would correspond to the long-term marginal cost of installing new capacity. The lower wholesale prices resulting from the TGC scheme may therefore be temporary.

Somewhat counter-intuitively, these effects mean that the *retail* price that consumers pay for electricity can *either increase or decrease* due to a green certificate scheme. There are two distinct and offsetting effects first, there is an upward pressure on retail prices as consumers pay the extra costs of generation from green sources. Against these extra costs, however, consumers benefit from the lower *wholesale* price occasioned by the TGC scheme's restriction of the market share of non-green electricity. In competitive market conditions, this effect in isolation would lead to lower *retail* prices as well. The net effect of these two factors on retail prices is therefore ambiguous, and depends in a complicated way on the size of the green quota and the way green and non-green electricity supply respond to changes in the wholesale electricity price. As noted above, however, the lower wholesale prices may be primarily a short-term phenomenon, so the long-run effect of the TGC scheme ultimately will be higher retail prices.

The TGC scheme also has a potential impact on overall electricity demand. In the very short run, electricity demand may be fixed, as consumers may not immediately adjust their consumption patterns. In the slightly longer term, however, demand will respond to price increases or decreases. As noted, for a given generation stock, retail prices may either increase or decrease as a result of the TGC scheme, and consequently electricity demand may also either increase or decrease (to the extent that demand responds in this time window).

In the longer term, a TGC scheme would tend to increase retail prices, with concomitant lower demand for electricity. This leads to further reductions in the demand for non-green electricity (relative to a 'business as usual' case with no TGC scheme).

3.2.2. Complications in 'Real-World' Electricity Markets

As with the EU ETS, the effects of the TGC programmes can differ as a result of real-world conditions. The Technical Report discusses a series of cases that could cause the effects described to differ from the case presented. Note that regulatory treatment is not likely to affect the impacts of a green certificate programme on electricity prices, because the costs associated with the purchase of certificates would likely be considered allowable costs under a regulatory approach. Issues that might have a bearing on the effects of a green certificate programme include:

- Presence of a voluntary market for green electricity;
- Inclusion of pre-existing or otherwise viable green electricity supply;
- Regulation of green certificate prices (e.g., price floor or price ceiling); and
- Differences in the geographic scope of the TGC market and the relevant electricity market.

For example, consider the effects of differences in geographic scope. The preceding discussion implicitly assumes similar geographic scope of the green certificate programme and the electricity market (e.g., both are relevant for a given Member State or for the EU as a whole). The electricity price effects may differ if the geographic scopes are not the same—for example, if a Member State instituted a green certificate programme on its own but was part of a larger regional or EU-wide wholesale electricity market. In this case, the green

certificate programme may have no effect on wholesale electricity prices, but retail electricity prices would still increase to reflect the 'tax' required by the green certificate programme.

3.3. Summary

Table 3.1 summarises the impact of a TGC scheme on key variables in electricity markets. As with the equivalent table for the EU ETS, this table ignores the effects of other policies (EU ETS or white certificate programme).

Table 3.1
Summary Impact of a TGC Scheme on Key Variables

Variable	Effect of TGC scheme	Comments
Wholesale electricity price	Reduced in short-term	Short-term wholesale price decreases as the amount of price-setting non-green generation decreases.
	Unaffected in long-term	In the long-term, wholesale electricity prices are determined by the cost of adding new generation capacity.
Retail electricity price	Varies in short-term	Net effect depends on balance of decreased wholesale prices and 'tax effect' of certificate obligation.
	Increased in long-term	In the long-term, wholesale prices do not decrease, so retail prices unambiguously increase because of the added cost of certificates.
Electricity demand	Varies in short-term	Demand may increase or decrease, depending on the net effect on retail prices. In the very short-term, electricity demand is likely to be unchanged.
	Reduced in long-term	In the long-term, electricity demand decreases in response to higher long-term retail prices.
Non-green generation	Reduced	Non-green generation is reduced both by the green quota reserving a share of the market for green electricity, and by the overall reduction in electricity demand.
Green generation	Increased	Renewable generation increases as mandated by the green quota.
CO_2 emissions	Reduced	CO_2 emissions decrease as green generation replaces more CO_2-intensive non-green generation.
Investment in conventional generating capacity	Reduced	New green generation capacity leads to less need for the addition of other new conventional capacity.
Investment in end-user energy efficiency	Varies in short-term	Investment in energy efficiency is affected by the retail price of electricity, the effect on which is ambiguous in the short-run.
	Increased in long-term	In the long-term, retail electricity prices rise, producing increased incentives for investment in energy efficiency.
Investment in new renewables	Increased	Investment is increased until generation meets the green quota.

4. Tradable White Certificate Schemes and Effects on Electricity Markets

The development of policies to encourage end-user energy efficiency measures is motivated by the belief that a number of barriers exist for end-users of electricity (or other energy) to improve the efficiency with which they use energy. With such barriers, electricity prices (both current and expected) alone would not incentivise optimal investment in energy-saving technology, such as more efficient appliances or industrial processes, and thus there would be public policy gains from mandating requirements for improved energy efficiency. Gains often mentioned include environmental objectives (e.g., reduction of emissions from electricity production) and energy security objectives (by reducing reliance on foreign energy sources).

Currently, the UK, Italy and France have existing or planned TWC schemes to achieve energy savings, with the aim to reach the desired level of energy savings in the most cost-effective manner. In these schemes, tradable white certificates are created when end-users undertake certain eligible energy efficiency activities. Each certificate represents a verified 'unit' of energy savings arising from these activities. The requirement to purchase and deliver to the regulator a set number of white certificates is placed on some target group (typically energy suppliers) during each compliance period. As in the case of TGC schemes, a market is established by making certificates tradable, helping ensure that energy savings are achieved where it is least costly to do so.

As with previous sections, we review the effects of white certificate schemes on the electricity market, and summarise the key points in a table at the end of the section.

4.1. The White Certificate Market

The white certificate market can be understood in terms of a market for 'energy efficiency measures' ('EEMs'), where the supply of EEMs depends on the technologically available means of achieving energy savings. Existing schemes focus on household energy use and include among eligible measures activities such as building insulation or switching to more energy-efficient appliances. It is in principle possible to allow non-household energy consumers to generate certificates as well; for example, industrial EEMs such as the installation of combined heat and power ('CHP') generation could be made eligible.[5] Consumers would generally be prepared to pay more to reduce their energy use if the cost savings were greater, and thus there would be greater demand for EEMs if the price of energy were higher.

White certificate targets are often denominated as a requirement to achieve *additional* energy savings, beyond the amount that would be undertaken in a baseline scenario without the TWC scheme. In practice, it may be very difficult to define 'energy savings' as a commodity in this fashion. Some EEMs will be undertaken by consumers without any specific policy intervention, and the counterfactual baseline therefore may not be easy to verify. It may

[5] As noted, CHP is sometimes included in *green* rather than white certificate schemes.

therefore be uncertain whether or not the EEMs undertaken are in fact additional because of the difficulty of determining the relevant baseline. Also, energy savings from a given investment in energy efficiency (e.g., installation of better insulation) cannot be measured simply as a reduction in energy use because the increased efficiency reduces the price of 'comfort' (e.g., indoor heating on a cold day) and thus may lead households to want more 'comfort' (e.g., heat another room in the house) and thereby use more electricity.[6]

Despite the practical difficulties, TWC schemes nonetheless generally incorporate provisions that seek to limit support for efficiency measures to those that would not have been undertaken in the absence of the TWC scheme. This is an important design feature that has implications for the potential interactions of TWC schemes with the EU ETS, as we discuss below.

The market for EEMs created by a TWC scheme depends upon differences in the cost of reducing energy among various EEM opportunities. The implied cost per amount of electricity 'saved' relative to the baseline differs between the set of available EEMs. By establishing a competitive market for certificates authenticating that such savings have been undertaken, white certificate schemes help distribute energy efficiency activities so that the most cost-effective EEMs are undertaken. Generally speaking, EEMs are likely to become increasingly costly as the cheapest options are exhausted, and the price of certificates therefore increases with a more ambitious energy savings target.

4.2. Impacts of TWC Schemes on Electricity Markets

This section considers the basic impacts of a TWC scheme on the electricity market, and then considers 'real world' complications.

4.2.1. Electricity market impacts of TWC schemes

Increases in energy efficiency due to a white certificate programme will have two principal and offsetting effects on the demand for electricity. First, there is a technological effect, as energy efficiency measures result in a reduction in the demand for electricity. One way to describe this is as a reduction in the price for 'energy services': less electricity is needed to achieve a given level of 'electricity service' (e.g., heating comfort), and so the price of the service is lower. Second, the lower price for such energy services leads households and firms to increase the amount of such services that they demand; for example, where one room was previously heated, two may be heated after the efficiency improvement is effected. This second response is often referred to as the 'rebound effect' and it at least partly offsets the initial reduction in electricity use.

The *net* effect of a TWC scheme on the retail electricity market is likely to be to reduce the quantity of electricity demanded, though the size of the reduction depends on the size of the rebound effect. A lower level of demand also corresponds to a lower wholesale price of electricity, as the marginal generating unit is likely to be cheaper when smaller volumes are produced. In competitive markets, or if certificate expenditure is included in the allowable

[6] This is often referred to as the 'rebound effect' of energy efficiency measures and is discussed below.

costs used for price determination in regulated market, this will also result in a lower retail electricity price.

Countervailing this, retail prices are pushed up because suppliers of electricity face the additional cost of purchasing certificates. Assuming the required number of certificates is linked to the amount of electricity supplied, this constitutes an increase in the marginal cost of supplying electricity. In competitive markets, the marginal cost increase will be passed on to end-users, pushing up retail electricity prices.

The net effect on retail prices is therefore ambiguous. Factors influencing the impact include the effectiveness of the energy efficiency projects financed, the extent to which electricity supply responds to prices, and the price-sensitivity of electricity demand (including the rebound effect).

The costs of TWC schemes may be split between electricity market participants in a complex way. Retail electricity price changes affect all consumers, while the direct benefits of energy efficiency measures accrue only to those implementing the measures. 'Free-riders' (consumers who would have installed energy efficiency measures anyway but nonetheless receive certificates) constitute the consumer group benefiting the most, while consumers not implementing any measures benefit the least. All consumers potentially stand to gain from benefits that are unrelated to the electricity markets (e.g., emissions reductions).

4.2.2. Complications in 'Real-World' Electricity Markets

The impact of TWC schemes on electricity markets may be modified by aspects of electricity market regulation and structure in ways similar to those described in the case of TGC schemes. For example, international trade in electricity normally implies national wholesale prices that are less free to respond to changes in domestic demand, while international certificate trade may be complicated by the fact that end-users face different retail prices (and therefore different pre-existing incentives for investment in energy efficiency).

There are also a number of ways in which the effects of TWC schemes may be different from those of TGC schemes. Notably, TWC quotas are often smaller than those of TGC schemes, and the effect on volumes and wholesale prices may therefore not be significant in existing schemes. If the energy savings were as large as the amount of electricity mandated by TGC scheme quotas, the effects would be of comparable magnitude.

In liberalised markets, the nature of the certificate obligation and target is also of importance. The overall TWC target is typically defined as an absolute amount of additional electricity savings, rather than a proportion of total electricity consumed. If this absolute target were apportioned between suppliers so that the requirement to generate energy efficiency savings were tied to electricity sales (and not specified as an absolute number of kWh saved), then the retail provider would incur added costs linked to added electricity sales. In this case, as with the equivalent green certificate programme, the white certificate programme would constitute a 'tax' on electricity sales, with costs being passed on to end-users.

In contrast, if the target were not linked to the amount of electricity supplied, the scheme would impose a 'lump-sum' cost that would not necessarily be passed on by suppliers to end-

users. In this situation, shareholders might at least in the near-term absorb the costs of the programme, and retail electricity prices would be lower than if the programme target were linked to electricity sales.

4.3. Summary

Table 4.1summarises the impact of a TWC scheme on key variables in electricity markets. As with the other summaries, this list ignores the effects of the EU ETS and any TGC programme.

Table 4.1
Summary Impact of a TWC Scheme on Key Variables

Variable	Effect in host country	Comments
Wholesale electricity price	Reduced in the short-run	For an existing generation merit order, lower electricity demand leads a lower-cost marginal generator, and hence lower wholesale prices.
	Unaffected in the long-run	In the long run wholesale electricity prices are determined by the cost of adding new generation capacity.
Retail electricity price	Likely increased	Increased by costs of energy efficiency investment, although may be somewhat offset by lower wholesale prices.
Electricity demand	Reduced	Investment in electricity efficiency reduces demand, although extent depends on the balance between 'rebound effect' and 'technology effect'. Additional change in demand may result from consumer response increased retail electricity price.
Non-green generation	Reduced	Due to lower total electricity demand. Marginal plant likely to be non-green.
Green generation	Likely unchanged	Effect depends on the position of green generating units in the merit order. Most existing renewables have low short-run marginal cost and therefore are unlikely to be affected by reduced demand.
CO_2 emissions	Reduced	Decreased non-green electricity generation leads to lower emissions. Size of effect depends on the emissions intensity of marginal plant.
Investment in conventional generating capacity	Reduced	Lower long-term demand and wholesale prices mean lead to less new investment.
Investment in end-use efficiency	Increased	Increased due to obligation and availability of subsidy. May also be increased by price response if consumer prices increase.
Investment in new renewables	Reduced	Lower wholesale electricity prices leads to less investment in generating capacity overall, including new renewables.

5. Impacts of Green and White Certificate Schemes on the EU ETS

The previous sections provide information on how the various schemes—the EU ETS and the green and white certificate programmes—would operate in isolation. This section and the next two sections build on this information to consider the interactions among the various programmes. As noted above, the emphasis in this project is on how the green and white certificate programmes might affect the EU ETS, although we consider the opposite influences as well (i.e., how the EU ETS affects the green and white certificate programmes).

This section considers the most basic effects that the presence of a green or white certificate programme might have on the EU ETS. The following two sections provide additional details regarding the interactions with the green and white certificate programmes, respectively. Specifically, this section discusses the following three major potential effects of the green/white certificate programmes on the EU ETS:

- effects on overall CO_2 emissions;
- effects on the overall cost of reducing CO_2 emissions; and
- effects on the impacts that the EU ETS has on electricity markets.

The first general conclusion, which may not hold under certain circumstances, is that TGC and TWC schemes do not contribute any *additional* CO_2 reductions in a given compliance EU ETS period, as emissions are fixed by the EU ETS cap.[7] In this context, we include a discussion of why it would not be appropriate to provide CO_2 allowances for emissions reductions due to green/white certificate programmes, as some commentators have proposed.

A second general conclusion is that the cost of achieving a given CO_2 level called for in the EU ETS is likely to be higher with certificate schemes than without.[8] As noted below, this conclusion may be modified in some circumstances. For example, there may be emissions that are affected by TWC schemes that are not covered by the EU ETS.

5.1. Effects of Green/White Certificate Schemes on Total CO_2 Emissions

A defining feature of a cap-and-trade scheme such as the EU ETS is that, assuming adequate enforcement and full compliance, total emissions from covered sources are limited by the aggregate cap. This feature of the EU ETS has important implications for its interaction with other policies. Coupled with comparable assumptions regarding the idealised operation of product markets, it implies that *additional policies to reduce the CO_2 emissions of sectors participating in the EU ETS will have no immediate CO_2 reduction benefits.* Furthermore, as

[7] As discussed in more detail below, an exception to this general conclusion are emissions from household *fuel* use, though the conclusion holds for household electricity use.

[8] Note that we do not consider the desirability of certificate schemes and thus this conclusion does not imply that green and white certificate programmes are undesirable.

will be discussed below, such policies are likely to increase the overall costs of meeting the emissions cap.

5.1.1. General Effects of Green/White Certificate Programmes

To illustrate the general effect on overall CO_2 emissions, consider the case of a TGC scheme. The scheme leads to lower CO_2 emissions from the electricity generation sector, as some conventional non-green generation is displaced by lower-emitting green generation. This 'frees up' a number of CO_2 allowances that would otherwise have been used to cover emissions from electricity generation, and generators can therefore either sell more allowances or purchase fewer allowances. As the supply of allowances is fixed, however, aggregate emissions will not have changed. Instead, other participants whose emissions are unaffected by the TGC scheme will use any 'freed-up' allowances to cover offsetting increases in emissions (or reduced emissions abatement). As the allowance market is EU-wide, the offsetting emissions increases may take place in other Member States; *national* emissions may therefore decrease as a result of a TGC scheme, although *EU-wide* emissions would not.[9] For a given cap, the emissions reductions that would have taken place (e.g., fuel switching, energy efficiency measures) are 'crowded out' by the TGC scheme, and the replaced by the (mandated) use of renewable generation as a means to reduce emissions.

A very similar 'crowding out' effect applies to the effects of TWC schemes on carbon emissions from electricity generation: the mandated energy efficiency activities reduce electricity demand, and the freed-up allowances no longer required by electricity generators could be sold to other participants in the scheme.

5.1.2. Implications for Proposals to Provide CO_2 Allowances for Renewable and Energy Efficiency Programmes

The overlapping outcomes and environmental objectives of different market-based approaches to environmental policy suggest that the certificates/allowances of various trading schemes could be made fungible across schemes. Such fungibility has been implemented, for example, in the EU ETS through the Linking Directive, which makes JI and CDM credits valid for compliance.[10]

It also has also been suggested that trading should be allowed between the EU ETS and TGC/TWC schemes in EU Member States. Such a proposal would allow companies to use the CO_2 reduction implicit in a TGC/TWC for EU ETS compliance. However, in this case the EU ETS would be linked to CO_2 reduction measures *within* the EU. Unlike in the case of most CDM/JI credits, allowing CO_2 credits for TGC/TWC projects could lead to problems of *double counting* of carbon emissions reductions. This is explicitly addressed and prohibited

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[9] This is somewhat complicated by the linking of the EU ETS to CDM/JI projects. TGC/TWC schemes may lead to less use of CDM/JI credits and greater European emissions reductions. In this case, emissions reductions would be shifted from CDM/JI sources to ones covered by the TGC/TWC scheme. The international *distribution* of emissions may therefore change, but the total *amount* emitted, once CDM and JI credits are taken into account, would not.

[10] Most JI and CDM projects will apply to emissions reductions outside the EU, although some credits may be earned within EU Member States.

for CDM/JI credits in the Linking Directive. There are two related concerns (Zapfel and Vainio 2001):

- *double coverage*: where two separate carbon allowances are surrendered for a one-tonne increase in physical emissions;[11] and
- *double crediting*: where two separate carbon allowances are generated from a one-tonne decrease in physical emissions.

Carbon allowances created through over-compliance with TGC targets and sold into the EU ETS would lead to double crediting. First, the displaced fossil fuel generation would free up EU ETS allowances that would be used to cover emissions elsewhere. Second, an approximate equivalent volume of new allowances would enter the EU ETS via the conversion of green credits into EU ETS allowances. Since this double crediting would not be offset by double coverage, the prior cap in the EU ETS would be exceeded.

5.1.3. Circumstances under which TGC/TWC schemes may contribute additional CO_2 emissions reductions

There are three main categories of circumstances under which TGC or TWC schemes could contribute additional CO_2 emissions reductions.

First, if certificate schemes reduce emissions from sources not covered by the EU ETS, these reductions may be additional. Notably, the EU ETS does not cover emissions from household fuel consumption, and TWC schemes may therefore contribute additional CO_2 reductions from these sources. However, this only refers to direct fuel use, and any reductions in household *electricity* use resulting from a TWC scheme would not reduce overall CO_2 emissions. Also, as all grid-connected electricity is included in the EU ETS, TGC schemes cannot contribute any additional reductions in this way.

Second, there is the possibility that the reductions achieved under TGC and TWC schemes would enable lower caps for future phases of the EU ETS. Individual Member States may choose to account for the reductions achieved through TGC or TWC schemes when setting future total caps for their NAPs. Also, lower national CO_2 emissions may lead to a different outcome in negotiations about national emissions targets in periods after 2012.

Finally, there is the theoretical possibility that the TGC/TWC schemes could be so stringent that they alone would reduce emissions below the EU ETS cap. In this situation, the EU ETS would not be binding, and allowance prices would drop to zero. In practice this situation is very unlikely.

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[11] A cross-border example of double coverage would be the export of electricity from country A, which has an emissions trading scheme where electricity generators surrender allowances, to country B, which has an emissions trading scheme where electricity consumers surrender allowances. Both the seller of the electricity (generators) in country A and the purchaser of the electricity (consumers) in country B would need to surrender allowances to cover the emissions associated with this electricity, which means the emissions would be covered twice by two separate trading schemes. A primary motivation for introducing a harmonised ETS throughout the EU was to avoid such problems.

5.2. Effects of Green/White Certificate Schemes on Costs of Reducing CO_2 Emissions

This section considers the effects of green and white certificate programmes on the overall cost of reducing CO_2 emissions. As noted, our overall conclusions are that while the costs under the EU ETS programme would be reduced, green/white certificate programmes would increase the overall cost of meeting the reductions called for under the EU ETS. We discuss these effects in the following sections.

5.2.1. Impact of Certificate Schemes on the 'Cost' of the EU ETS

From the narrow perspective of the EU ETS itself, a green or white certificate programme would reduce the price of allowances as well as the overall cost incurred in the programme. This occurs because the overall constraint of the EU ETS is relaxed: in effect, as the TGC/TWC scheme leads to emissions reductions from sources covered by the scheme, some abatement already has been 'paid for' through the certificate scheme. In terms of the allowance market, the emissions reductions caused by the TGC/TWC scheme reduce demand for allowances, and hence lower the price required to respect the given emissions cap. As a result, the cost of compliance for EU ETS participants is reduced and the cost of the EU ETS 'in isolation' is lower.[12]

The size of the effect on allowance prices would likely be small in practice. A significant decrease in allowance prices will only occur if the emissions reductions achieved through the certificate schemes were a significant proportion of the total emissions reductions required from EU ETS sources. Most green and white certificate schemes are confined to individual Member States and may therefore each have little impact on the allowance price, though the simultaneous use of certificate schemes by a number of Member States could have a more noticeable impact. Also, the price impact may be dampened if the EU ETS were closely linked to potential future international carbon markets, or if the allowance price were linked to the prices of CDM/JI credits.

5.2.2. Impact of Green/White Certificate Schemes on the Overall Costs of Reducing Emissions

Although the costs attributed solely to the EU ETS would fall with a green or white certificate programme in place, the overall cost of achieving the cap would actually increase. An important feature of a cap-and-trade scheme like the EU ETS is that, under a standard set of assumptions regarding the competitive operation of the allowance market, the scheme will allow an emissions target to be met at least cost. In equilibrium, marginal abatement costs will be equalised across sources and equal to the allowance price. The decreased allowance price resulting from TGC and TWC schemes therefore does not mean that the *total* cost of reducing CO_2 emissions is lower with certificate schemes than without. On the contrary, the overall cost is likely to be ***higher***, as the measures undertaken under TGC and TWC schemes

[12] As noted in Section 5.1.3, the analysis changes if the emissions cap is reduced to reflect any emissions reductions expected from certificate schemes. In this case, the allowance price will be ***higher*** than it would be without the certificate schemes.

are not likely to be identical to those undertaken under the cost-minimising optimum of the EU ETS alone.

Put differently, the certificate scheme would substitute some relatively high cost abatement options (e.g., renewable energy) for some lower-cost CO_2 abatement options that otherwise would have been chosen by EU ETS participants (e.g., fuel switching).[13] The cost increase from implementing the TGC or TWC scheme is higher than the cost decrease that results from lower allowance prices. Hence, while the impact of the EU ETS *alone* on electricity consumers will be lower with the certificate scheme, the *overall* price impact (i.e., from the EU ETS and certificate scheme combined) will be higher. As noted, this accounting does not include the benefits of the green and white certificate schemes that are unrelated to the abatement of CO_2 emissions. It should not therefore be interpreted as determining whether a particular certificate scheme is desirable or not.

5.2.3. Circumstances under which Green/White Certificate Schemes Could Provide Cost-Effective CO_2 Reductions

It is useful to consider whether there are circumstances in which green or white certificate programmes could lead to reductions in the cost of meeting a CO_2 cap. As a general matter, green or white programmes might provide cost-effective CO_2 reductions if the EU ETS did not incentivise the most cost-effective measures for cutting emissions.

As discussed above, the EU ETS may not lead to the lowest-cost means of achieving the cap if electricity prices do not increase to reflect the costs associated with the programme. If, for example, electricity regulators did not allow the opportunity costs to be reflected in electricity prices, electricity prices would be 'too low' and thus some cost-effective reductions in CO_2 emissions would not be undertaken. Similarly, if the method used to allocate allowances included updating (for example, by allocating allowances to new entrants), the electricity price would not rise to reflect the full costs of the programme.

5.3. Effects of Green/White Certificate Schemes on Electricity Market Impacts of the EU ETS

Certificate schemes could also alter the electricity market effects of the EU ETS in several ways. Most immediately, the lower CO_2 allowance price discussed above would lead to a smaller increase in electricity wholesale cost, both because compliance costs would be smaller and because the costs of residual emissions would be lower. As noted above, however, the overall electricity market cost of both the EU ETS and the green or white certificate programme in the long run is likely to be greater than if only the EU ETS were in place.

Under some circumstances, even though total costs would be higher, *consumers* could theoretically be better off.

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[13] If the measures incentivised by TGC schemes and TWC were in fact the most cost-effective available, then these measures would anyway be incentivised by the EU ETS, without the need for additional programmes.

As noted, the effect of the TGC scheme is to reduce the price of CO_2 allowances. If the reduction in emissions costs of the marginal generator were larger than the average cost of the certificate scheme per unit electricity, then consumers could pay less with a TGC scheme than with the EU ETS.[14] As noted above, in order for a certificate scheme to affect the price of allowances appreciably, schemes would need to be in place across a wide geographical region and have large quotas. The benefit to consumers would come at the expense of infra-marginal low-emitting electricity producers who would otherwise benefit from the higher CO_2 price that would prevail in the absence of the TGC scheme. Some of this loss is the reflection of the use of a more expensive, green technology, and some of it is a transfer from producers to consumers.

The certificate schemes could have an even greater impact on the wholesale electricity price effects of the EU ETS if either the TGC quota or the demand reductions required by a TWC scheme were large enough to displace substantial amounts of (non-green) generation. This would potentially result in a change in the emissions characteristics of the average marginal generation technology. For example, a TGC scheme could displace mainly natural gas, causing higher-emitting coal-fired generation to be on the margin more frequently. As outlined above, this effect would influence how the electricity price would be affected by the EU ETS, with higher increases in wholesale prices when the CO_2 emissions intensity of the marginal producer is higher. The precise impact depends on the particular configuration of green quota, merit order, and demand.

A similar effect could result from a decrease in overall electricity demand, occasioned either because retail prices increase under a TGC scheme or because energy efficiency activities are undertaken under a TWC scheme. This too has the potential to alter the emissions characteristics of the marginal producer, and therefore to influence the wholesale price effect of the EU ETS.

In the long run, these effects may be less significant than other influences on the emissions intensity of the marginal producer, notably the entry of new plants either to meet electricity demand growth or to replace any closures of existing plants.

5.4. Summary

The following two tables summarise the effects of introducing (or tightening the target) of a stylised TGC and TWC scheme in a country that is already participating in the EU ETS. Table 5.1 shows the effects on key variables in the case of a TGC scheme, while Table 5.2 summarises the effects in the case of a TWC scheme.

[14] The two quantities to be compared are 1) the change in the allowance price multiplied by the emissions intensity (CO_2 / MWh) of the marginal generator and 2) the green quota multiplied by the certificate price. If 1) is greater than 2) consumers will benefit from lower prices.

Table 5.1
Summary effects of a TGC Scheme in the presence of the EU ETS

Variable	EU ETS	EU ETS and TGC scheme	Additional impact of introducing the TGC scheme
Wholesale electricity price	Increased in short term	Likely increased in short term	Lower price than with EU ETS alone in the short-run, due to lower allowance price and smaller volume of (price-setting) non-green generation.
	Increased in long term	Increased in long term	Long-run prices unaffected by the TGC scheme. Price therefore increases due to EU ETS.
Retail electricity price	Increased	Likely increased	Retail price reduced lower by wholesale price, but increased by cost of certificates. Long-run impact is a net price increase.
Electricity demand	Reduced	Reduced	In the short-run demand can either be higher or lower than with EU ETS alone, as the TGC scheme contributes to lower wholesale electricity prices.
			In the long-run, wholesale prices are unaffected by the TGC scheme, and demand therefore lower than with the EU ETS alone (owing to higher retail prices).
National non-green generation	Reduced	Reduced	Lower generation than with EU ETS alone due to both restriction through the green quota and likely lower demand.
National green generation	Likely Increased	Increased	Existing renewables have low short run marginal cost and should take preference in merit order. They are therefore unlikely to be affected by reduced demand.
National CO_2 emissions	Reduced	Reduced	Emissions from national electricity generators decrease. National emissions decrease provided at least some of the thus 'freed-up' allowances are sold to operators in other countries.
EU CO_2 emissions	Reduced	Reduced	Unaffected by TGC scheme. With EU ETS in place, TGC scheme has no impact on EU CO_2 emissions within a given EU ETS phase.
Investment in end-use efficiency	Increased	Increased	Impact compared to the EU ETS alone depends on the effect on retail prices. These are likely to increase in the short run, and unambiguously increase in the long run.
Investment in new renewables	Increased	Increased	Increase to the level set by the green quota.
EU ETS allowance price	-	-	Lower, due to displacement of CO_2 emissions from non-green generation. Abatement paid for by electricity consumers and non-green producers through TGC scheme

Notes: Columns 2 and 3 compare the effects of the policies to a situation where there is no regulation. Column 4 outlines the incremental effect of adding a TGC scheme—i.e., it compares the effects in column 3 to those in column 2.

Table 5.2
Summary effects of a TWC Scheme in the presence of the EU ETS

Variable	EU ETS	EU ETS and TWC scheme	Additional impact of introducing the TWC scheme
Wholesale electricity price	Increased	Likely increased	Lower price than with EU ETS alone
Retail electricity price	Increased	Likely increased	Retail price reduced by lower demand, but increased by cost recovery. Likely increased price if supply is insensitive to price.
Electricity demand	Reduced	Reduced	Lower demand than with EU ETS alone
National non-green generation	Reduced	Reduced	Lower generation than with EU ETS alone due to lower demand.
National green generation	Likely increased	Likely increased	Existing renewables have low short run marginal cost and should take preference in merit order. Generation therefore is unlikely to be affected by reduced demand.
National CO_2 emissions	Reduced	Reduced	Ambiguous. Lower emissions from national electricity generators. But whether national emissions are lower depends upon who purchases and uses the surplus EU ETS allowances.
EU CO_2 emissions	Reduced	Reduced	Unaffected by TWC scheme. With EU ETS in place, TWC scheme has n impact on EU CO_2 emissions within a given EU ETS Phase.
Investment in end-use efficiency	Increased	Increased	Increased investment due to TWC subsidies. Offset by ambiguous incentive from retail prices – but latter also likely to increase
Investment in renewable energy	Increased	Likely increased	Lower incentive to invest due to lower wholesale electricity prices
EU ETS allowance price	-	-	Lower, due to displacement of CO_2 emissions from generation. Abatement paid for by consumers through TWC scheme

Notes: Columns 2 and 3 compare the effects of the policies to a situation where there is no regulation.
Column 4 outlines the incremental effect of adding a TGC scheme—i.e., it compares the effects in column 3 to those in column 2.

6. Impact of the EU ETS on Green Certificate Schemes

In addition to the above general conclusions about the impact of TGC and TWC schemes on CO_2 emissions and the allowance market, there are a number of other potential interactions that may arise that are specific to the two schemes. This section discusses interactions between the EU ETS and TGC schemes, while the next section provides a discussion of additional interactions of the EU ETS with TWC schemes.

6.1. Effects of the EU ETS on the Green Certificate Market and Scheme Costs

As noted above, the EU ETS on its own increases the competitiveness of green generation. The support offered by the EU ETS means that a given amount of green generation can be achieved with less support from other programmes.

This effect has a direct impact on the market for green certificates. As discussed in Section 3.1, for any given green quota there is a 'green cost gap'—i.e., a difference between the marginal cost of green production, and the marginal revenue available from the wholesale electricity price. The EU ETS raises the wholesale electricity price, thereby decreasing the cost gap for a given green quota. With a competitive green certificate market, certificate prices will also decrease, automatically adjusting to the lower level of support required. In normal circumstances, the price of EU ETS allowances and the price of green certificates are therefore negatively correlated. In theory, a sufficiently high allowance price could on its own bring about enough green generation to meet the TGC quota, in which case the certificate price would fall to zero. In practice, the cost of CO_2 abatement through green generation, disregarding other benefits related to renewable energy, is generally significantly higher than the prices that have been observed in the EU ETS, and certificate prices therefore are positive.

A lower certificate price decreases the cost of the TGC scheme 'in isolation.' As more support for green generation is 'paid for' by the EU ETS, less needs to be paid through the TGC scheme. This results in a smaller impact of the TGC scheme alone on retail electricity prices. The combined effect, however, would not necessarily be smaller.

The long-run effects of the EU ETS on electricity demand may also affect certificate prices. First, with the green generation requirement expressed as a proportion of overall electricity generated, lower overall demand leads to a smaller absolute amount of green electricity being supplied. This would normally correspond to a green supplier with lower marginal cost. Second, the same effect occurs for non-green generation, resulting in lower wholesale electricity prices. As the certificate prices depends on the difference between the wholesale price and the marginal cost of green generation, the net effect depends on which effect is larger in absolute terms.

6.2. Effects of the EU ETS on the Amount of Green Generation

While the EU ETS may result in lower certificate prices, the design of most TGC schemes means that the support offered by the EU ETS for green generation does not result in a larger percentage of green generation. Demand for certificates is fixed by the green quota, and additional support from the EU ETS therefore does not change the amount of green generation. The theoretical exception to this is if the quota is sufficiently small / allowance price sufficiently high that green generation in fact exceeds the quota.

Where the TGC requirement is defined as a proportion of total electricity consumption the absolute amount of green generation will vary with the total amount of electricity demanded. If, in the long-term, the EU ETS reduces electricity demand, it will therefore also *reduce* the absolute amount of green generation.

There may also be renewable or other low-emitting generation technologies that are not classified as 'green', i.e., whose generation output is ineligible for green certificates. For example, many schemes exclude certain forms of large-scale hydro generation or generation from pre-existing renewables installations. These 'non-green' renewables *do* benefit from the extra support offered by the EU ETS through higher electricity prices. Insofar as it is possible to invest in more such capacity, the EU ETS may therefore result in a larger amount of such renewable generation even where there is a green certificate scheme.

6.3. Effects of Interactions between the EU ETS and Green Certificate Schemes on the Costs and Benefits to Different Groups

The combination of an EU ETS and a TGC scheme may also have implications for the costs and benefits affecting different groups of producers and consumers. Generally speaking (and in competitive markets), the support for renewables offered by the EU ETS is paid for by end-users through higher electricity prices. In contrast, the costs of the support offered in a TGC scheme is split in the short run between non-green producers and consumers. This means that for given levels of CO_2 reductions / green generation, consumers pay a higher proportion of short-term costs through the EU ETS than through a TGC scheme. Even if total costs of achieving CO_2 reductions are higher with a TGC scheme, electricity consumers may therefore in the short term be worse off with the EU ETS than they would be with the TGC scheme alone. These different distributive effects may not persist in the long-run, as retail prices for electricity adjust to include the full additional cost of green generation.

6.4. Effects of Market and Scheme Design Features on Interactions

The above effects may be altered depending on various features of the green certificate scheme, the EU ETS, and the relevant electricity markets. The following are implications of the interactions between green certificate programmes and the EU ETS that take into account the following complications:

- regulatory treatment of the electricity sector;
- relative geographic scope of the EU ETS, electricity markets, and TGC schemes; and
- alternative design parameters of TGC schemes.

6.4.1. Implications of Electricity Regulation

The most relevant aspect of electricity market regulation is to what extent the increased costs to electricity market producers and suppliers are allowed to be passed through to end-users. As noted throughout, the retail electricity price effects may be substantially lower if either generators or suppliers have to absorb some of the cost of either EU ETS allowances or green/white certificates.

It seems likely that the opportunity cost of CO_2 emissions is being reflected in electricity prices, but the extent of this effect is likely to vary from market to market. As noted above, failure to pass on the full cost would increase the cost of meeting the CO_2 target but would not affect achievement of the CO_2 target. In addition, electricity demand would be higher and thus it would be necessary to adopt more costly methods of reducing CO_2 emissions.

Under TGC schemes the additional costs to generators or suppliers would be in the form of direct payments—rather than 'opportunity costs'—and thus would likely be included as allowable costs in regulated electricity prices. The outcome would in this respect be similar to that in a competitive liberalised electricity market. By contrast, under the EU ETS it is currently uncertain whether the full CO_2 opportunity cost will be reflected in electricity prices in all Member States where these are regulated. There is the possibility that the pass-through to either wholesale or retail prices is constrained through regulatory action.

This would affect the interaction with TGC schemes. Notably, if wholesale prices were not to rise by the full opportunity cost the EU ETS would offer less support to green generation. As noted this would not affect the total amount of green generation, but would make higher certificate prices necessary in order for the green quota to be achieved. The effect would be similar to that of a lower allowance price.

Regulated electricity markets are frequently also characterised by a small number of players. In this case, either the buyers or sellers of green or white certificates may be very small, with important implications for the certificate market. If the number of suppliers of certificates is small these may enjoy oligopoly power, with resulting higher certificate prices. As the link between the marginal cost of green generation and certificate prices is weaker, the aim of promoting low-cost generation is likely to be compromised.

Conversely, if the regulated market has a single purchaser (e.g., the regulated utility), a number of deviations from the competitive pattern may ensue. The purchaser may be able to obtain different prices from different suppliers ('price discrimination'), in which case there would no longer be a single TGC price. Bilateral contracts and bargaining may also become more common, with potentially wasteful strategic behaviour interfering with the functioning of the TGC market. Also, the anticipation of a 'captive' market where existing suppliers have already paid their fixed costs may deter potential investors from entering the market. Even if new entry takes place, it may not be that which represents the least cost of generation, as other factors may become relevant (e.g., short-term marginal cost).

6.4.2. Implications of Differences in Geographic Scope

The interactions between TGCs and the EU ETS may also depend on differences in the geographic scope of the two forms of programme. The effect of the EU ETS on wholesale electricity prices may vary in different geographic electricity markets if these have different technologies on the margin. This means that the support offered by the EU ETS for green generation will also differ across Member States. Greater integration of European electricity markets (e.g., further development of EU-wide markets) would lessen these differences.

The fungibility of certificates across Member States is also of relevance for the interaction with the EU ETS. If certificates are not fungible certificate prices are likely to differ (especially if electricity markets are also fragmented) and therefore to offer varying levels of support for investment in green generation. Conversely, if green certificates are fungible across Member States, certificate prices will equalise. This does not imply that investment incentives will be equal, however, as these will depend also on wholesale electricity prices and on the cost of eligible technologies. Even if costs were all the same, the location and type of investment in green generation would differ from the case of purely national certificate markets. However, a given level of green generation can still be achieved at lowest overall cost (as certificate prices are as low as is consistent with the quota).

Also, as noted, the CO_2 reductions achieved by national programmes are likely to be small compared to the total emissions covered by the EU ETS. The effect on the EU ETS would therefore also be limited. This form of interaction would therefore only be of significance either through a cumulative effect of Member States' individual programmes, or through a programme spanning several (large) Member States.

Finally, international trade in certificates may affect CO_2 emissions in individual Member States, as imported certificates lead to lower CO_2 emissions in the originating but not in the importing country. As noted, such impacts only affect the distribution of CO_2 emissions across Member States. EU-wide CO_2 emissions are fixed by EU ETS cap.

6.4.3. Implications of Various Design Features

The interactions may also vary depending on various design parameters of the TGC scheme and the EU ETS. We discuss some of the most important of these below.

6.4.3.1. Effects of relative programme stringency

The interactions between TGC schemes and the EU ETS will depend on the stringency of the two programmes. A tighter EU ETS cap leads to a higher allowance price, with higher electricity prices and a smaller 'green cost gap' as a result. Therefore, for a given green quota and merit order, TGC prices will fall as the EU ETS cap is tightened. Conversely, a more ambitious target for green generation will displace more CO_2 emissions from the power sector and allow other EU ETS participants to undertake less abatement. EU ETS allowance prices will therefore be lower, although the effect may not be large in individual national programmes, as discussed.

6.4.3.2. Effects of the EU ETS in the presence of certificate price constraints

Many TGC schemes include provisions that result in constraints on certificate prices. For example, a fixed penalty for non-compliance effectively provides a price ceiling on certificates, as suppliers or consumers would choose to pay the penalty if it is cheaper to do so than to buy certificates.

Such constraints potentially affect interactions between policies. As discussed above, the combined support offered by the EU ETS and the TGC scheme is normally kept constant at the minimum level necessary to attain the green quota; if the EU ETS allowance price increases, the certificate price will decrease (and vice versa). If certificate prices are not free to adjust, however, this automatic balancing of allowance and certificate prices may no longer take place. For example, if the price ceiling keeps the certificate price below the level it would reach in an unconstrained market, then an increase in the allowance price may in fact offer additional support to green generation. A similar situation may arise with a price floor, as certificate prices may be prevented from falling below the floor as allowance prices increase. A high allowance price makes it less likely that the certificate price ceiling will be binding in a particular period (and more likely that a certificate price floor will be binding).[15]

6.4.3.3. Effects of EU ETS allowance allocation on electricity prices

As the impact of the EU ETS on TGC schemes is mediated through the wholesale electricity price, any programme design factors that change the effects of the EU ETS on electricity prices also have the potential to change interactions between the two types of programmes. Specifically, factors that mute the effect of the EU ETS on electricity prices also mean that green certificate prices will be higher for a given target, as less support for green generation would come from the EU ETS.

One example of such a design factor is the EU ETS allowance allocations. Many Phase I NAPs provided allocations to new entrants, which lower the cost of adding generating capacity. This also reduces the impact of the EU ETS on the long-term marginal cost of generation and therefore on long-term wholesale electricity prices.[16]

Other forms of 'updating' allocation approaches may have similar effects. For example, if future allocations are based on current emissions, then the current cost of emitting CO_2 is partly offset by future benefits of emitting CO_2, in the form of higher allocations. This in turn would result in lower current wholesale electricity prices.

Depending on the specific new entrant policies and eligibility for green certificates, it is also possible that allowance allocations could be available to some 'green' generator new entrants,

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[15] There are also scheme designs that are similar both to price controls and to freely operating markets. The UK Renewable Obligation Certificates ('ROCs') can be bought directly from the regulator at a fixed 'buyout' price but revenue is subsequently recycled to holders of ROCs generated through green electricity generation. With this setup, there is a price-correcting mechanism linked to the quantity of generation in place even as a price-ceiling protects ROC consumers from price rises.

[16] As noted in section 5.2.3, TGC schemes could be used in part to counteract the reduced incentives for investment in low-emitting technology due to new entrant allocations.

but not others. This would in effect reduce the long-run marginal cost of eligible technologies, with consequent lower long-run green certificate prices. If some but not all green technologies (e.g., biomass generation, or CHP, but not wind power) are eligible for allocations this may distort the choice of green technologies.

6.4.3.4. Effect of the EU ETS on certificate targets

The negative correlation between allowance and certificate prices results because the EU ETS lowers the green cost gap (the difference between green generators' marginal cost and the wholesale electricity price) for a *given* amount of green generation. If, however, green targets are adjusted to take into account the effects EU ETS, then this negative correlation does not necessarily ensue. Indeed, achieving *additional* green generation may become increasingly expensive as low-cost generation opportunities (e.g., advantageous sites for wind farms) are exhausted, leading to *higher* certificate prices. Defining 'additionality' may, however, be very difficult in practice; for example, the EU ETS allowance price varies on a day-to-day basis, so the determination of which prospective sources of green generation were 'additional' would in principle need to be revised with every change in the allowance price.

6.4.3.5. Effect of the EU ETS on other low-emissions technologies

Many TGC schemes exclude pre-existing or otherwise 'economically viable' renewable generation sources and thus these sources would not receive the subsidy provided by green certificates. Unlike in the case of eligible 'green' technologies, there is therefore no offsetting effect in the form of decreasing certificate prices when the price of EU ETS allowances increases. These sources therefore do benefit from the price effects of the EU ETS, as the wholesale electricity price increases without increasing their marginal cost of generation.

In addition, some TGC schemes include among eligible technologies net CO_2-emitting sources, such as fossil fuel-fired combined heat and power installations. Such installations are affected differently by the EU ETS, as their costs increase, unlike the costs of non-CO_2-emitting 'green' sources. In this case, the EU ETS may therefore change the relative profitability of green technologies. Like all changes to the green merit order this effect has the potential to alter the price of certificates as well as the composition of green electricity supply.

6.4.3.6. Effects of temporal flexibility

The EU ETS and TGC schemes also differ in the extent to which there are provisions that mitigate risk related to the varying price of certificates and allowances. For example, there is some flexibility to bank and also borrow allowances within compliance phases, and to some extent between compliance phases. Such flexibility has been more restricted in TGC schemes. Temporal flexibility generally provides a means of reducing price volatility as well as the cumulative costs of the programme, so all else being equal, one might expect EU ETS allowances to offer greater certainty than TGCs. More generally, the volatility of certificate prices may be moderated by support offered through the EU ETS (and vice versa), assuming fluctuations are to some extent uncorrelated.

Of course, the full effect on certainty and investor confidence may depend equally or to a greater extent on a number of factors specific to each programme, e.g., the perceived credibility of commitment, or the feasibility of targets. For example, many certificate schemes have targets set for a longer time horizon than does the current EU ETS, and so in this respect may actually offer greater certainty than does the EU ETS.

6.4.3.7. Effects of EU ETS links to other programmes

If the EU ETS allows extensive use of Joint Implementation and Clean Development Mechanism projects, the effects of the EU ETS on TGC schemes (and vice versa) could be substantially diminished. The EU ETS affects TGC schemes through effects on electricity markets, which would be reduced if JI/CDM credits reduced CO_2 allowance prices. Conversely, the certificate programmes affect the cost of the EU ETS programme in part through effects on the price of CO_2 allowances; if the price of CO_2 allowances is set by the cost of JI/CDM credits, these price effects would be smaller.

6.4.4. Summary

Table 6.1 summarises the effects of the EU ETS in the presence of a TGC scheme. The columns represent:

- the effect of the TGC scheme alone, compared to no regulatory intervention;
- the effect of the TGC scheme and EU ETS in combination, compared to no regulatory intervention; and
- the additional effect of the EU ETS (i.e., the effect of the instrument combination compared to the TGC scheme alone).

The effect of the EU ETS can be interpreted either as introducing the EU ETS, or as the consequences of a tighter emissions cap and concomitant higher allowance prices.

Table 6.1
Summary effects of the EU ETS in the presence of a TGC scheme

Variable	TGC scheme	TGC scheme and EU ETS	Additional impact of introducing the EU ETS
Wholesale electricity price	Reduced in short term	Varies in short term	Higher wholesale prices due to the EU ETS counteract the price decrease due to the TGC scheme. The net short-term effect cannot be determined *a priori*.
	Unaffected in long term	Increase in long term	Long-term prices are determined by the cost of new entry, and hence will increase as a result of the EU ETS.
Retail electricity price	Varies in short term	Likely increased in short term	Higher price than with TGC scheme alone, as wholesale price increase translates into retail price increase. However, the increase from the EU ETS is *smaller than the full opportunity cost of allowances*, as it is partly offset by lower certificate prices.
	Increased in long term	Increased in long term	
Electricity demand	Varies in short term	Likely reduced in short term	The EU ETS further lowers demand by increasing retail prices.
	Reduced in long term	Reduced in long term	
National non-green generation	Reduced	Reduced	EU ETS is likely to cause a further reduction in the amount of national non-green generation, as overall demand is likely to contract.
National green generation	Increased	Increased	EU ETS contributes *no additional support for green generation* as the amount is fixed by the green quota and the certificate price adjusts.
			In the long term, lower levels of demand may mean that the total absolute amount of green generation as well as certificate prices decrease.
National CO_2 emissions	Reduced	Reduced	Emissions reduced further by decrease in total electricity production.
EU CO_2 emissions	Reduced	Reduced	Lower emissions than with TGC scheme alone
Investment in end-use efficiency	Varies in short-term	Likely increased	Higher retail prices with the EU ETS than with TGC scheme alone means that incentives for investment in end-user energy efficiency are strengthened.
	Increased in long-term	Increased in long-term	
Investment in green energy	Increased	Increased	No additional investment with the EU ETS, as investment is determined by the green quota.
Green certificate price	-	Reduced	The EU ETS causes the certificate price to decrease.

Notes: Columns 2 and 3 compare the effects of the policies to a situation where there is no regulation. Column 4 outlines the incremental effect of adding the EU ETS —i.e., it compares the effects in column 3 to those in column 2.

7. Impact of the EU ETS on White Certificate Schemes

The effect of the EU ETS on the operation of TWC schemes is different from interactions in the context of TGC schemes in several important respects. As in the previous section, we discuss the impact of the EU ETS on scheme objectives in the form of investment in energy efficiency, the impact on the TWC market and the cost of the scheme; and on the electricity market costs and benefits of the scheme to different groups. Finally, we also consider the impact of different market and design features on these interactions.

7.1. Effects of the EU ETS on Investment in Energy Efficiency

As described above, the EU ETS has the effect of increasing the support available for investment in energy efficiency. This occurs because the EU ETS leads to higher retail electricity prices, which in turn normally results in higher investments in energy efficiency. The EU ETS therefore leads to greater energy savings.

In contrast to the situation under TGC schemes, the added support offered by the EU ETS *does* potentially have an impact on the total amount of investment in energy efficiency even when a TWC scheme is in place. This hinges on differences between the way that requirements under the two types of certificate schemes typically are set. Whereas TGC requirements typically are denominated in terms of a quota of overall electricity consumption, TWC scheme targets typically have been defined in terms of *additional* investment in energy efficiency. In theory, only activities over and above those which would have occurred in the absence of the TWC scheme are eligible for certificates. The higher electricity price induced by the EU ETS may therefore result in additional energy efficiency measures, but if the TWC scheme is fully enforced these will not be eligible for white certificates. As noted, however, in practice such 'additionality' may be very difficult to verify.

7.2. Effects of the EU ETS on the Cost of White Certificate Schemes

Assuming additionality can be enforced, the fact that the total amount of energy-efficiency investment increases means that, unlike the in the case of TGC schemes, the price of white certificates is not expected to decrease because of higher electricity prices under the EU ETS. As described in Section 4.1, the price of certificates depends on the available supply of energy efficiency measures, and on the level of demand. As noted above, the demand is fixed by the additional energy savings required to fulfil the TWC scheme quota.

While the EU ETS does not affect the demand for EEMs, it may change the available supply. With higher electricity prices more EEMs will be undertaken. As these initially available cheap investment opportunities are exhausted, the cost per unit energy saving is likely to increase. Instead of decreasing, the price of white certificates may therefore in fact *increase* because of the EU ETS. The precise result depends on the characteristics of both the supply and demand of EEMs.

If the additionality of energy savings to those undertaken because of the EU ETS were not fully enforced these conclusions could change. Consumers would be willing to supply certificates at a lower price if part of the eligible EEMs were 'paid for' by higher electricity prices. In this case, the behaviour of the certificate price in response to the EU ETS allowance price is similar to that of the TGC market, as outlined above.

There may also be a long-term effect that reduces additionality in practice. If the EU ETS allowance price is sufficiently high, the resulting amount of energy savings may be so large that future energy savings targets are reduced. If market failures prevented electricity prices from resulting in energy efficiency investment to the optimal level, this would not necessarily occur, however.

7.3. Effects of Interactions on Costs and Benefits to Different Groups

The interactions between the EU ETS and TWC schemes are generally of lesser significance than in the case of TGC schemes. First, assuming additionality can be ensured, there is no negative correlation between EU ETS allowance prices and white certificates, and the potential for the EU ETS directly to influence the cost borne by any particular group is therefore smaller than in the case of TGC schemes. Second, EU ETS and TWC schemes are anyway similar in that, in competitive markets, the short-term electricity market costs of the schemes are expected to be borne by end-users of electricity.

As noted, however, there is a possibility EU ETS may indirectly push up the price of white certificates. In this case, the TWC scheme's impact on retail prices will increase relative to a scenario in which there were no EU ETS. The benefit to 'free-riders' will be even higher, as will the cost to non-participating consumers. However, this is not so much the result of an 'interaction' as of the fact that a greater total amount of energy savings is taking place, and at a higher overall cost. The results are therefore similar to an increase in the stringency of the TWC scheme target.

7.4. Effects of Market and Design Features on the Interactions

Many of the implications for scheme interactions of electricity regulation, geographic scope, and scheme design are similar to those of TGC schemes. The below discussion concentrates on those points where implications for TWC schemes differ from TGC schemes. Further discussion of the aspects common to TGC schemes can be found above.

7.4.1. Differences between TWC and TGC interactions with electricity prices

There are two major differences between the targets in TGC and TWC schemes, as these are currently implemented in the EU. First, TGC schemes typically state the regulatory target in terms of a proportion of the electricity used, whereas TWC targets typically are denominated as an absolute amount of electricity. Second, while in a TGC scheme the target can be directly measured as dispatch from eligible green generation sources, the target in a TWC scheme is for a specified quantity of 'energy saving' to be achieved through investment in energy saving projects. This cannot be directly measured, but relies on the construction of a counterfactual scenario (baseline) of what would have occurred absent the TWC scheme.

These complications mean that TGC and TWC schemes interact differently with electricity prices. In TGC schemes, the amount of support provided by the combination of electricity prices and the certificate price is constant for a given quota and supply of green electricity; if electricity price increase, certificate prices therefore decrease. This effect does *not*, however, arise in TWC schemes with an absolute target. If the retail electricity price increases, (because of the EU ETS or for other reasons), the incentive to invest in energy efficiency also

increases. However, these savings would be incorporated into the *revised* counterfactual baseline scenario in which the TWC scheme were absent, and would therefore not be eligible for white certificates. There is therefore no direct link between the price of allowances in the EU ETS and the certificate price in a TWC scheme.

The fact that electricity and certificate prices are not directly linked to each other also means that interactions between the EU ETS and a TWC scheme are different in several important respects to those between the EU ETS and a TGC scheme. However, as discussed, the 'additionality' requirement upon which these results are based may be very difficult to enforce in practice. For example, as with green quotas, energy savings targets are typically set in advance, while EU ETS allowance prices fluctuate daily. If the additionality requirement is not enforced, the interactions will start to resemble those discussed in relation to TGCs schemes, above.

7.4.2. Implications of Electricity Regulation

Electricity market regulation affects the interaction of the EU ETS and TWC schemes similarly to the case of TGC schemes. Constraints on the pass-through of EU ET (opportunity) costs to electricity prices would result in less significant interactions. Specifically, lower electricity prices as a result of regulation would lead to less energy savings outside of the TWC scheme.

The main difference to the TGC case is that energy savings respond to *retail* prices, while green generation depends on wholesale prices. Constraints on the retail price increases resulting from the EU ETS would therefore affect the objectives of TWC schemes even where they would have little effect on TGC schemes.

The small number of participants in the supply-side of traditional regulated electricity markets may make it difficult to establish a competitive certificate market. In this case, the cost-effectiveness benefits of TWC schemes may be smaller.

7.4.3. Implications of Differences in Geographic Scope

In an international TGC scheme customers may face different retail electricity prices, and therefore have different levels of incentive for energy savings. As discussed, this would not have any direct effects if the TWC scheme target were denominated in terms of additional energy savings. Investment would be determined only by the technological opportunities for cost-effective and eligible energy efficiency measures, and the relative geographic scope of electricity and TWC markets is therefore less important in this respect.

The CO_2 reductions achieved by national TWC programmes are likely to be small compared to the total emissions covered by the EU ETS. The effect on the EU ETS would therefore also be limited. This form of interaction would therefore only be of significance either through a cumulative effect of Member States' individual programmes, or through a programme spanning several (large) Member States.

As with TGC schemes, international trade in certificates may affect CO_2 emissions in individual Member States, as imported certificates lead to lower CO_2 emissions in the originating but not in the importing country. As noted, such impacts only affect the

distribution of CO_2 emissions across Member States. Total emissions, however, will not be affected because of the overall cap-and-trade structure of the EU ETS.

7.4.4. Implications of Design features

As there is no direct link between certificate prices and electricity prices, the stringency of the EU ETS does not directly interact with the price level and achievement of the target in TWC schemes. The same conclusion holds for a number of other interactions. For example, certificate price constraints have no implications for targets if certificate and allowance prices are not correlated. Similarly, allowance allocation methods resulting in lower current or long-term electricity prices do not affect the cost of achieving the TWC target or the price of certificates. Provisions for temporal flexibility, or the role of effect of CDM/JI credits in the EU ETS on allowance prices, also do not directly influence the TWC scheme.

The exceptions to this are the indirect effects that may arise because the cost of additional energy efficiency investment increases as more are incentivised by the EU ETS. This might happen because the available cheapest measures are exhausted, causing the unit cost of further savings to be more expensive. In this case, TWC prices and electricity prices may in fact be *positively* rather than negatively correlated. Higher electricity prices would prompt a larger amount of energy savings outside the TWC scheme, making it increasingly expensive to achieve the TWC additional savings comprised in the TWC target. This effect may be relevant only in the longer term, as electricity consumption generally does not respond much to prices in the very short term.

This indirect effect is nonetheless likely to be small compared to the direct interactions that follow from a certificate programme with a relative quota and without the requirement of additionality to a counterfactual baseline. In terms of design parameters, the rules for verifying and enforcing additionality are therefore the one with greatest implications for the interaction of TWC schemes with the EU ETS.

7.4.5. Summary

Table 7.1 summarises the effects of the EU ETS in the presence of a TWC scheme. The columns represent:

- the effect of the TWC scheme alone, compared to no regulatory intervention;
- the effect of the TWC scheme and EU ETS in combination, compared to no regulatory intervention; and
- the additional effect of the EU ETS (i.e., the effect of the instrument combination compared to the TWC scheme alone).

The effect of the EU ETS can be interpreted either as introducing the EU ETS, or as the consequences of a tighter emissions cap and concomitant higher allowance prices.

Table 7.1
Summary effects of the EU ETS in the presence of a TWC scheme

Variable	TWC scheme	TWC scheme and EU ETS	Additional impact of introducing the EU ETS
Wholesale electricity price	Reduced in short term	Likely increased in short term	Higher price than with TWC scheme alone.
	Unaffected in long term	Increased in long-term	
Retail electricity price	Likely increased	Likely increased	Higher price than with TWC scheme alone
Electricity demand	Reduced	Reduced	Lower demand than with TWC scheme alone.
National non-green generation	Reduced	Reduced	Lower generation than with TWC scheme alone
National green generation	Likely Unchanged	Likely Unchanged	Existing renewables have low short run marginal cost and are likely to take preference in merit order. Generation therefore is unlikely to be affected by reduced demand.
National CO_2 emissions	Reduced	Reduced	Lower emissions than with TWC scheme alone
EU CO_2 emissions	Reduced	Reduced	Lower emissions than with TWC scheme alone
Investment in end-use efficiency	Increased	Increased	Higher than with TWC scheme alone, owing to higher retail prices
Investment in new renewables	Reduced	Varies	Higher than with TWC scheme alone, due to higher wholesale prices but unchanged costs to renewables.
White certificate price		-	Either reduced or unchanged, depending upon interpretation of 'additionality'.

Notes: Columns 2 and 3 compare the effects of the policies to a situation where there is no regulation. Column 4 outlines the incremental effect of adding the EU ETS —i.e., it compares the effects in column 3 to those in column 2.

8. Conclusions and Implications

The EU ETS and certificate schemes are complex programmes. Moreover, their effects depend upon the nature of electricity markets as well as the details of the programmes. The following are the major conclusions and implications of the study.

- The presence of green and/or white certificate programmes generally would not affect EU-wide CO_2 emissions from the EU ETS, although other facets of the EU ETS would be affected. (These conclusions assume competitive markets.)
  - The CO_2 allowance price would be reduced.
  - The overall cost of meeting the CO_2 cap would be increased (but this comparison does not take into account the non-CO_2 benefits of these other programmes).
  - Changes in the location of CO_2 allowance purchases/sales due to these other programmes could affect national CO_2 emissions (although, as noted, EU-wide emissions from covered sources would not change). However, national emissions reductions through these programmes would not contribute towards meeting Member States' Kyoto commitments as they would be accompanied by increased sale/reduced purchase of CO_2 allowances from their participating facilities within the EU ETS.
  - The burden of EU ETS costs and electricity price impacts on different producers and consumers could be affected by the presence of a green or white certificate programme. The effects on a particular group depend upon the many specifics of the programmes, especially on whether the certificate programme is large enough to affect the price of CO_2 allowances, and also on the electricity and certificate market conditions.
- Providing CO_2 credits for green or white certificates would not be desirable, primarily because it would represent double counting and thus undermine the EU ETS CO_2 cap.
- There are some circumstances in which a green or white certificate programme could yield additional EU-wide CO_2 reductions.
  - In theory, the programmes could be so stringent as to reduce CO_2 emissions below the cap, although this seems highly unlikely.
  - The presence of the programmes could lead governments to reduce allowances to participating facilities and thus create a lower cap that reflects the impact of these programmes when establishing the total amount of allowances of the Member State's NAP. In this case, the country also would ensure that the expected CO_2 emission reductions count towards its Kyoto commitment.
  - The white certificate programme might include emissions outside the facilities covered by the EU ETS (e.g., support for insulation programmes that reduce household/commercial fuel use).
- There are some circumstances in which a green or white certificate programme might lower the cost of meeting the EU ETS CO_2 cap.
  - If retail electricity prices did not fully reflect CO_2 costs (e.g., because of cost-based regulation that excluded opportunity costs or because the allocation process included

'updating'), the retail price effects of green or white certificate programmes *could* compensate for the inadequate price signal.

§ Conclusions regarding the effects of the EU ETS on green certificate programmes are generally similar to those for the other direction effects.

  – The EU ETS generally would not affect the amount of green generation but would decrease the price of green certificates, change the location of green generation, and alter the distributional effects of a achieving a green generation target.

  – If the green target were relative (i.e., green generation as a percentage of total generation), reductions in overall electricity demand due to price effects of the EU ETS could decrease somewhat the quantity of green generation.

  – In contrast, if the green certificate programme included a price ceiling, the EU ETS could increase somewhat the quantity of green generation.

§ Conclusions regarding the effects of the EU ETS on white certificate programmes are somewhat different both because of the white certificate programme coverage (beyond sources covered by the EU ETS) and its nature as a credit-based (rather than a cap-and-trade) programme.

  – Electricity price effects of the EU ETS could lead to energy savings that were in addition to savings due to the white certificate programme.

  – Like the green certificate programme, however, the presence of the EU ETS would alter the distributional effects of a white certificate programme.

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