# European Experience with Tradable Green Certificates and Feed-in Tariffs for Renewable Electricity Support

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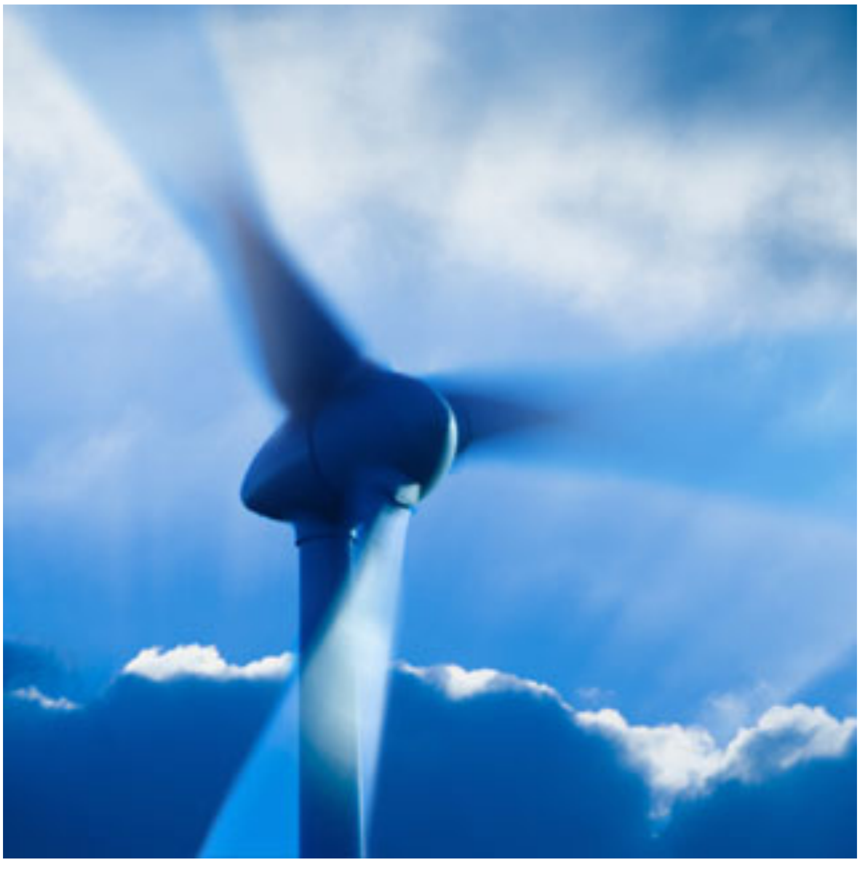

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# List of Abbreviations

| | |
|---|---|
| **CDM** | Clean Development Mechanism |
| **DSO** | Distribution System Operator |
| **EU** | European Union |
| **EC** | European Commission |
| **EP** | European Parliament |
| **EU ETS** | European Union Greenhouse Gas Emissions Trading Scheme |
| **FIT** | Feed-in Tariff |
| **GC** | Green Certificate |
| **GHG** | Greenhouse Gas |
| **GoO** | Guarantee of Origin (for RES-E) |
| **MS** | Member State (of European Union) |
| **MWh** | Megawatt per hour |
| **REC** | Renewable Energy Certificate (tradable certificate for RES-E production) |
| **RE** | Renewable Energy |
| **RES** | Renewable Energy Sources |
| **RES-E** | Renewable Energy Sources – Electricity (i.e., renewable electricity) |
| **ROC** | Renewable Obligation Certificate (synonym for REC in UK) |
| **RPS** | Renewable Portfolio Standard |
| **TAC** | Transfer Accounting Certificate (similar to TGC, used for international transfers) |
| **TEA** | Tradable Emission Allowances (for GHGs) |
| **TGC** | Tradable Green Certificate (synonym for REC in EU) |
| **TSO** | Transmission System Operator |

# Executive Summary

Policies to reduce greenhouse gas (GHG) emissions and support the production of electricity from the renewable energy sector (RES-E) in the European Union (EU) are highly heterogeneous. Separate policy mechanisms exist for GHG emission reductions and RES-E support, and each Member State has drafted its own policies to achieve EU-wide goals, particularly in the area of RES-E support. In many cases, separate policies are in place for different RES-E technologies.

This state of affairs is partly a result of the EU's tradition of delegating decision-making authority to individual Member States to the greatest degree possible. However, it is also the result of several specific consensuses (or lack of consensuses) on the best choice of policy in these areas.

As discussed in section D, the EU has a strongly established policy of GHG emission reductions, based on its commitments under the Kyoto Accord, and a desire to reduce GHG emissions further in the future. The primary mechanism for achieving these emission reductions is via an EU-wide trading system for GHG emission quotas. However, RES-E technologies are at present a relatively expensive way to achieve GHG emission reductions, and the GHG trading system is not likely to induce strong development of renewable energy on its own. Nonetheless, as discussed in section E.1.1, there are compelling reasons to support ongoing development of RES-E projects even if they are not justified by the near-term value of their GHG emission reductions. These include their contributions to regional energy security and industrial development, and the likelihood that they will need to play a larger role in emission reductions in the future. Consequently, the EU and its member states are likely to maintain dual policies supporting both GHG emission reductions in general and RES-E development in particular for the foreseeable future.

The EU plays an important role in setting national targets for RES-E development, but has not yet mandated specific approaches for each member state to use to achieve these targets, nor has it required states to establish systems for exchanging RES-E support across borders (section C.2). Over the years, individual states have adopted a variety of mechanisms to support RES-E (section C.1). The predominant ones in effect now are feed-in tariffs (FITs) which provide a fixed payment per unit of electricity from RES-E projects over a number of years, and quota systems which rely on market-based exchange of tradable green certificates (TGCs) to achieve a pre-specified target for RES-E development at the lowest possible cost. Systems based on quotas and TGCs have strong theoretical support, but have proven more expensive and less effective than FITs in practice, so neither has emerged as the clear, best choice for RES-E support in Europe. The chief advantages of TGC systems are their popularity with market-oriented governments and their potential to achieve the greatest support of RES-E at the lowest cost. The chief advantages of FIT systems are their ability to provide customised support to different RES-E technologies and the security (and easy access to capital) that they provide for investors.

The EU has repeatedly considered introducing a harmonised system for RES-E throughout the region, but has not done so yet (section C.2.4). This is partly because of the difficulty in deciding whether TGC- or FIT-based systems would be more effective (and indeed, the answer to this question may be different for an EU-wide system than it would be for an individual member state). But it is also because there are some advantages to be gained by maintaining the current, heterogeneous approach: it avoids disrupting national systems at a time when investors crave policy certainty; it allows countries to adopt policies best suited to their own environmental, economic and social goals; it allows more time to see whether FIT- or TGC-based systems emerge as a clear winner; and it allows Europe to take advantage of the best aspects of both systems – potentially achieving some RES-E development at a low cost under quota systems, while also continuing development of less mature technologies under FIT systems.

Section E discusses the types of interaction that can occur between markets for electricity, TGCs and GHG emission allowances, on either a local or international level. The chief lesson from this section is that care must be taken in developing these policies and markets, to avoid unintended side-effects. For example, if a country has both GHG quotas and RES-E targets, changes to both should be coordinated so that an increase in RES-E targets will lead to a reduction in GHG emissions. On an international level, countries must take care to avoid having their investments in RES-E lead to increased exports of power, which would reduce allow neighbouring countries to achieve GHG reductions as a free-rider on these RES-E expenditures. Issues that apply on an international level in the EU can also apply with equal relevance to individual states or provinces within a country.

Section G of this report provides additional details on the policies in place in selected countries of the EU, including the nature of their RES-E support systems and the premium paid for RES-E under FIT or TGC systems.

# A. Introduction

This report provides an overview of the European experience with tradable green certificates (TGCs) and Feed-in Tariffs (FITs) for the support of production of electricity from renewable energy sources (RES-E). This report focuses on

(i) the relative performance of support schemes based on TGCs versus FITs in ensuring the deployment of RES-E (TGCs are exchanged among parties who are subject to a quota for production of RES-E, with the intention of achieving the collective quota at the lowest cost; FITs provide a high, fixed payment directly to RES-E projects for every unit of power they deliver to the grid);

(ii) the policy environment within which these support schemes are rooted (including policies developed at both the European Union (EU)-wide and national level, and policies for both greenhouse gas (GHG) emission reductions and RES-E support); and

(iii) the interactions between markets for TGCs, electricity and GHG emission permits.

RES-E support schemes and their design are currently subject to the national energy policies of the EU Member States as developed within the EU framework. In the EU the energy policy is structured on two levels – EU and national.

At *EU level* the energy policy has been focused for the last decade on three core goals: low consumer costs, increased generation of renewable electricity (RES-E), and reduced emission of greenhouse gases (GHGs). The aim is to simultaneously deploy RES-E and to reduce GHG emissions, with minimal costs to EU citizens in the context of a liberalized conventional electricity market. In pursuit of these goals, the EU energy sector is currently shaped mostly by the liberalisation of the conventional electricity market, the RES-E directive adopted in 2001 (the "2001 RES-E Directive") and the EU Greenhouse Gas Emission Trading Scheme (EU ETS). (Huber and Morthorst, 2004).

At *national level* the EU Member States have the freedom to decide on the type of RES-E support schemes to use and their design (Huber and Morthorst, 2004). Consequently, the EU is particularly rich in variations of different delivery mechanisms for increasing the use of RES-E with a low potential of developing an EU wide harmonised RES-E support scheme in the near future. Support schemes based on TGCs and FITs are dominant (Mitchell et al., 2006). The experience to date renders FIT as the success story (EC, 2005b) because of its effectiveness in reducing risks for RES-E generators (Mitchell et al., 2006; Sawin, 2004).

Quota support systems based on GCs require generally electricity suppliers to buy in each compliance period a certain percentage of their electricity supply from RES. In order to prove their compliance with the imposed quota, the incumbents have to submit with the relevant authorities the corresponding number of GCs. A GC is a "document" ascertaining the generation of one unit of electricity from RES (usually 1 MWh) which in turn displaces the carbon equivalent of the marginal unit of conventional electricity generation (Toke and Lauber, 2007). Besides proving compliance with the obligation, GCs can serve as trading instruments. Alternatively incumbents may comply with the quota obligation by buying GCs without acquiring any physical electricity from RES. GCs may thus become TGCs (Mitchell et al., 2000). The UK is considered the most representative market for this type of RES-E support scheme. UK had in 2006 close to 2,000 MW installed wind capacity (EWEA, 2006).

FIT systems have two components: (i) an obligation for the grid operators to buy all RES-E produced by the plants connected to their grid, and (ii) a feed-in tariff. Producers sell their RES-

E at a pre-set price per KWh. Such price is usually above market price for electricity and guaranteed for a number of years (Sawin, 2004; Muñoz et al., 2007). Spain and Germany are considered the most representative markets for this type of RES-E support scheme. For example, in 2006 Germany passed the 20,000 MW mark, thus being a leader in promoting wind energy (EWEA, 2006).

Section C.1 considers the relative performance of RES-E FIT and quota support schemes in some detail. This discussion is placed within an examination of the two levels of energy policy – EU and national, in Sections B, C and D. Section B presents an overview of the liberalisation of the EU's conventional electricity market, then section C presents the RES-E support policies that have been developed on both a national and EU-wide level. Then, Section D provides a brief discussion of the EU's GHG mitigation policy, with special attention to the EU ETS. Subsequently, the report moves on to addressing the national level.

Section E of the report draws on all this information and analyzes the interactions between the RES-E quota support scheme and the EU ETS at national and international level.

This is followed by a brief recap of the main findings of the report in Section F.

Section G is an annex which comprises background data on several EU countries that use TGC systems – Belgium, Italy, Poland, Romania, Sweden and the UK. Information in this section includes RES-E targets, TGC prices, main barriers to RES-E expansion, etc.

## B. Liberalisation of the European Electricity Market

The EU is set to create an internal single electricity market (EC, 2005a). The governing rules include: *unbundling* (the legal separation of electricity generation, transmission and distribution), *access to the network* (negotiated or regulated third party access or the single buyer procedure) and *reciprocity* (Member States need only give foreign companies as much access to their market as local companies have to the foreign market). To outweigh the negative effects of liberalisation on RES-E, Member States may require transmission and distribution system operators to grant priority in the dispatching to RES-E. Germany is one example in this respect (Muñoz et al., 2007).

From a legal perspective, the national retail markets were fully opened as of 1 July 2007. All European consumers can theoretically choose their supplier and benefit from competition. Nevertheless, these markets have in practice been national in scope, with limited competition (EC, 2008a). The main barriers identified include:

- excessively high network tariffs and a lack of transparency in their quotation due to insufficient unbundling and inefficient regulation;
- coexistence of open market segments and retail price regulation leading to restrictions to free and fair competition (EC, 2008a);
- a high level of market power among existing generating companies, due to illiquidity in wholesale and balancing markets which impedes new entrants;
- persistent bottlenecks in the gas and electricity infrastructure impeding cross-border trade and thus enforcing concentration in national markets (EC, 2008a; Jamasb and Pollitt, 2005);
- differential rates of market-opening that reduce the benefits to customers from competition and distort competition between energy companies by allowing cross-subsidies as companies restructure into pan-European suppliers (EC, 2002).

It should be noted that in 2006 the interconnection of the national markets was still low, limiting the import and export of electricity between countries.

| ***Country*** | ***Interconnection capacity in % of installed capacity of the country for the year 2005*** |
|---|---|
| U.K. | 3% |
| Spain | 4% |
| Italy | 8% |
| France | 12% |
| Germany | 13% |
| Belgium | 34% |

***Table 1. Interconnection rate of some European countries***
*Source: CapGemini, 2006*

# C. European Renewable Energy Support Schemes

A wide range of support schemes have been developed for the promotion of RES-E in the EU Member States. Direct support systems based on fixed, subsidised feed-in tariffs (FITs) and quota systems based on tradable green certificates (TGCs) are the main measures that have been employed. These are usually supplemented by other secondary instruments such as investment subsidies, tax waivers or accelerated depreciation schemes. This variety was made possible by the 2001 RES-E Directive, which allocated RES-E targets among Member States, but left the mechanism for delivering on these targets in the hands of each Member State (Mitchell et al., 2006). Consequently, the EU RES market is relatively protected and non-harmonised among Member States, and international RES-E trade is limited (Del Rio, 2005).

Section C.1 below discusses the advantages and disadvantages of the FIT- and TGC-based systems that have been established on a national level. Section C.2 then reports on the chief RES-E support activities that occur at the EU-wide level. These include the establishment of national targets for RES-E development; mandating the use of Guarantees of Origin (GoOs) to reveal the source of electricity delivered to customers; urging the removal of administrative barriers to the deployment of RES-E; and considering the prospects for a single, harmonised, EU-wide system of RES-E support.

## C.1. National-Level Renewable Energy Support

European RES-E support schemes to-date have been implemented exclusively on a national level, rather than an EU-wide level. Consequently, a variety of measures have been tried in different countries. The principal measures currently being used are feed-in tariffs – which provide a fixed, above-market price for RES-E – and quota-based systems – which rely on tradable green certificates (TGCs) to stimulate RES-E development (Mitchell et al., 2006). Each of these approaches has strengths and weaknesses, discussed below. At present, European countries appear to be moving more rapidly toward TGC-based systems, but the limited evidence now available suggests that FITs may actually be a more cost-effective way to support RES-E.

### C.1.1. Feed-in Tariffs (FITs)

Feed-in Tariffs (FITs) are among the simplest mechanisms for renewable energy support, and consequently have had a relatively long history in Europe.

FIT support schemes generally consist of:

(i) an obligation for the grid operator to buy all RES-E produced by plants connected to its grid, and
(ii) a feed-in tariff that ensures that RES-E producers receive a pre-set, above-market price per KWh, guaranteed for a number of years (some FITs provide a fixed premium above the market price of electricity, rather than a fixed purchase price).

FITs are similar to standard-offer contracts, in that they provide streamlined access to the grid and guaranteed, concessionary payments for electricity from RES-E projects over an extended period.

This structure is considered to have several benefits:

(i) reduced risk for RES-E project developers, leading to easier access to capital at a lower cost (FITs eliminate uncertainty about future RES-E subsidies or future prices for electricity and balancing services (Mitchell et al., 2006; EC, 2005b));
(ii) low transaction costs;
(iii) easy entry for small and medium enterprises, which have historically provided the bulk of technological innovation (Sawin, 2004); and
(iv) policy flexibility – the system can be adapted as technology and markets change over time (EC, 2005b);
(v) the ability to be site- and technology-specific, providing higher subsidies for immature technologies and less favourable sites that will be needed in the long run, without oversubsidizing projects that are already more competitive (EC, 2005b).

The FIT structure has several potential disadvantages:

(i) opportunities for cost-saving through international RES-E trade can be lost, because FITs generally require domestic production (EC, 2005b);
(ii) similarly, by attempting to "pick winners," technology- and site-specific FITs may end up investing in relatively overpriced projects; and
(iii) FITs do not automatically adjust if the cost of RES-E falls, so consumers may pay high prices for RES-E if tariffs are not adjusted over time (Sawin, 2004; EC, 2005b).

Some attempts have been made to address these issues through appropriate policy design. For example, in 2004 Germany introduced the "degressive" tariff and nationwide equalization scheme. The degression clause reduces the guaranteed tariff for new projects each year, promoting early deployment of renewables but also accounting for technological innovation, and eventually phasing out the subsidy entirely. (The degression rate is technology-specific, e.g., –2%/year for the wind tariff, or –5%/year for solar photovoltaics.) The nationwide equalization scheme distributes the costs of the RES-E FIT policy evenly among different regions of the country (Muñoz et al., 2007).

### C.1.2. Quota Support Schemes based on Tradable Green Certificates (TGCs)

Quota support schemes based on Tradable Green Certificates (TGCs) involve a RES-E quota set by the government. This quota is generally assigned to retail electricity providers, who must show that they have obtain the mandated share of their electricity from RES-E sources. They can demonstrate this by buying either RES-E itself or green certficates (GCs). A GC is a document certifying the generation of one unit of RES-E which in turn displaces the carbon equivalent of the marginal unit of conventional electricity generation (Toke and Lauber, 2007). As RES-E is indistinguishable from conventional electricity, GCs prove the former's "greenness". A GC becomes a TGC when the mechanism allows trading of GCs as a means of meeting the RES-E quota (Mitchell and Anderson, 2000).

Quota systems with TGCs have several advantages that make them particularly appealing to "market-orientated" governments (Mitchell et al., 2006):

(i) because RES-E from any source can contribute toward any participant's quota obligations, market actors would be expected to fund the least expensive projects to achieve any particular quota, minimizing costs for society as a whole;
(ii) quota systems fund RES-E projects without channelling additional money through government; and
(iii) the amount of RES-E to be developed is known in advance; this can be considered in one of two ways:

a. if no "opt-out" clause is included in the policy, then the quota sets a minimum level of RES-E capacity that is certain to be developed; OR
b. if participants are allowed to "opt-out" of their obligation by paying a set fee per kWh, then the quota can be regarded as an upper limit on the amount of RES-E that will be developed, and consequently the maximum possible cost of the policy is known in advance.[1]

TGC-based systems have some potential disadvantages as well, principally related to the increased risk for project developers under this mechanism:

(i) RES-E projects face uncertainty about the future value of electricity and the future cost of balancing services to meet firm loads; both of these quantities could be shifted in a less-profitable direction by aggressive increase in RES-E projects in later years (Mitchell et al., 2006);
(ii) RES-E projects face uncertainty about the future value of TGCs:
 a. if RES-E projects become more expensive over time due to a switch from less-expensive sites and resources to more expensive ones, then the cost of TGCs will rise, and early projects will obtain windfall profits, needlessly raising the cost of electricity;
 b. alternatively, if the cost of RES-E drops over time due to technological innovation, then the value of TGCs will drop, and early projects could be left with stranded costs that cannot be repaid;
(iii) due to these risks, financing for RES-E projects may be difficult to obtain or come at a high cost;
(iv) shortage of capital may exclude smaller participants from the market, reducing innovation and liquidity;
(v) costs of TGCs may rise or large price fluctuations may occur if markets include too few projects or traders and become illiquid (Mitchell and Anderson, 2000);
(vi) TGC systems are generally technology-neutral; consequently, they may pay windfall profits to less-expensive technologies or more favourable project sites;
(vii) the targets under TGC quota systems can serve as upper limits for development – there are no incentives to install more than the mandated level (Sawin, 2004);
(viii) the value of TGCs could be unstable when the system is near the target level; if the target is exceeded even slightly the value of TGCs could crash; if the target is missed, the cost of TGCs could spike arbitrarily high (unless there is an "opt-out" fee for participants); and
(ix) a long term and stable policy environment is essential for RES-E markets; for example, policy changes in Belgium, the UK and Sweden after 2002 caused investment instabilities even before they took effect (Ragwitz et al., 2005).

Points (iii)–(v) above introduce the possibility for a vicious cycle, some hints of which have been seen in the UK. Large, integrated energy companies are best able to bear the risks that RES-E projects face in the power and TGC markets, and indeed, developing such projects allows them to hedge risks that are faced by their retail divisions and non-renewable generating units. Large companies also have relatively deep supplies of capital available to fund these projects. In contrast, small and medium developers cannot readily finance RES-E projects from diversified balance sheets, and must instead turn to the capital market. However, these companies are exposed to the full risk of volatility in the electricity and TGC markets, and these risks make it difficult and expensive to obtain debt financing for these projects (Mitchell et al., 2006).

[1] A similar type of certainty can be achieved in FIT systems by capping the number of projects that can qualify for the FIT. It may be worth noting that either of these bounded approaches would provide only the *lesser* of the target level of RES-E or the amount of RES-E that can be delivered at or below the marginal cost set by the opt-out clause or FIT. Environmental economics suggests that it would be better to aim for whichever of these two values is best known, rather than the lesser of the two.

Consequently, most RES-E in the UK is produced by large generation companies that also have retail supply operations. It is believed that most TGCs are sold by the RES-E units to their parent companies' retail divisions, so relatively little trade takes place on the market (Mitchell et al., 2006). This in turn reduces the liquidity of the TGC market, further inhibiting entry by smaller firms.

### C.1.3. Comparison of Experience with FITs and TGCs

Figure 1 shows the evolution of RES-E support policies in several European countries since 1997. It is apparent that quota/TGC systems are being adopted rapidly, displacing FITs and other measures in several countries. However, TGC systems have been introduced only recently, and they are still in a transitional period (Morthorst et al., 2004; Ragwitz et al., 2005). The limited experience with this scheme leads to uncertainty about how it will function, how it will interact at EU level with other instruments, how it should be designed, and how certificates markets will evolve over time.

However, in the limited experience available so far, FIT systems have generally proved to be the most effective and cost-efficient support scheme in the EU (EC, 2005b; Haas et al., 2007). FIT systems appear to deliver more RES-E than quota systems, while paying a lower cost for power (Figure 2a) and providing lower subsidies (Figure 2b) (Ragwitz et al., 2005; EC, 2005b).

Germany, Spain, Denmark and Finland, all of which use FITs, are seen as the only countries on track to meet their national RES targets for 2010 (Ragwitz et al., 2004). In 2006 Germany's RES-E passed the 20,000 MW mark, closely followed by Spain, placing them both among the world's leading users of RES-E (EWEA, 2006). Additionally, turbine manufacturers in these countries account for the majority of world's turbine market and have achieved most of the technological development in the wind industry (Sawin, 2004). These results are mainly attributed to FITs reducing investment risks and maintaining low transaction costs (Sawin, 2004; Mitchell et al., 2006; EC, 2005b).

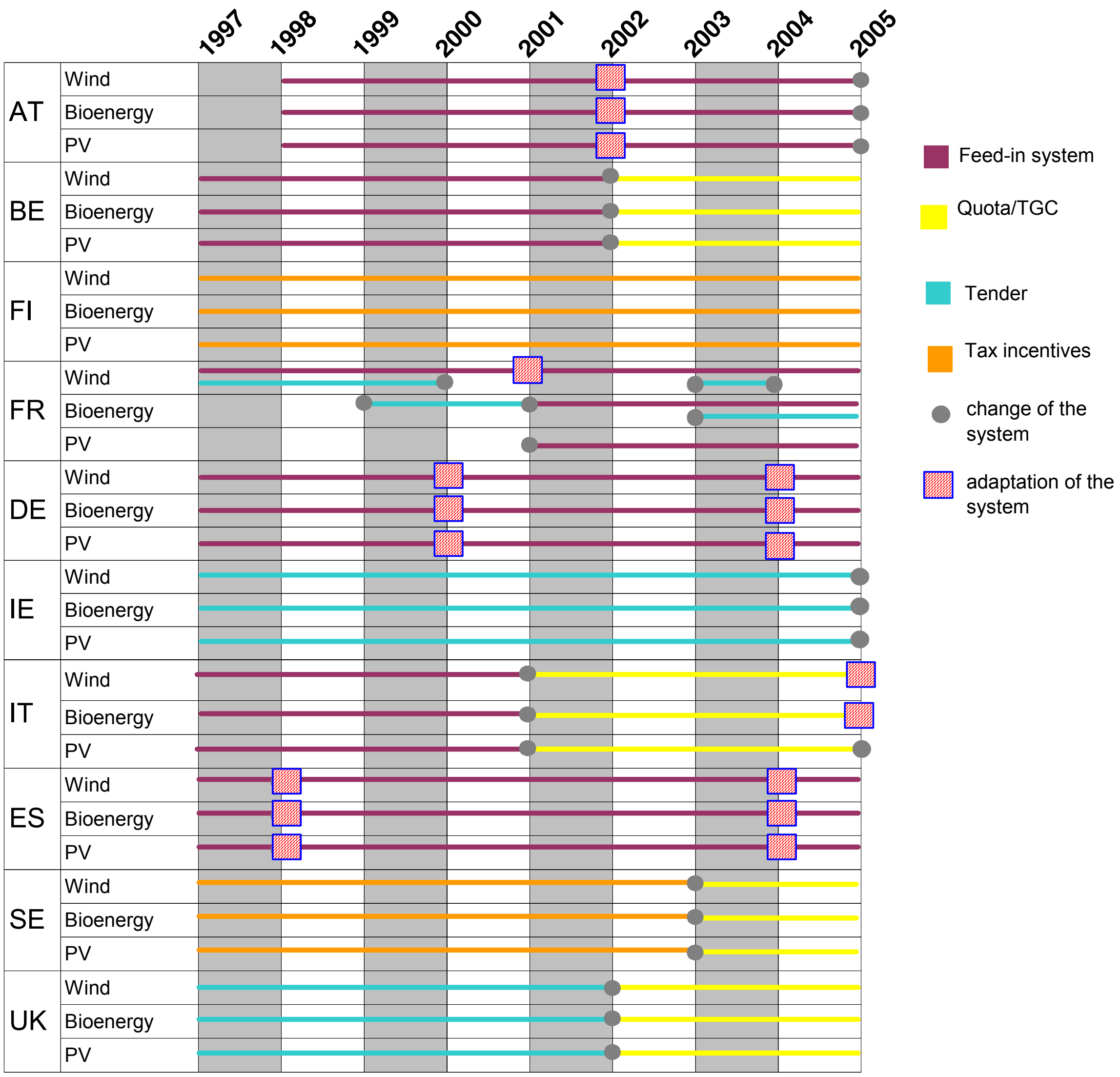


***Figure 1.*** *Evolution of RES-E support measures in several European countries (1997–2004)*
*Source: Ragwitz et al., 2005*

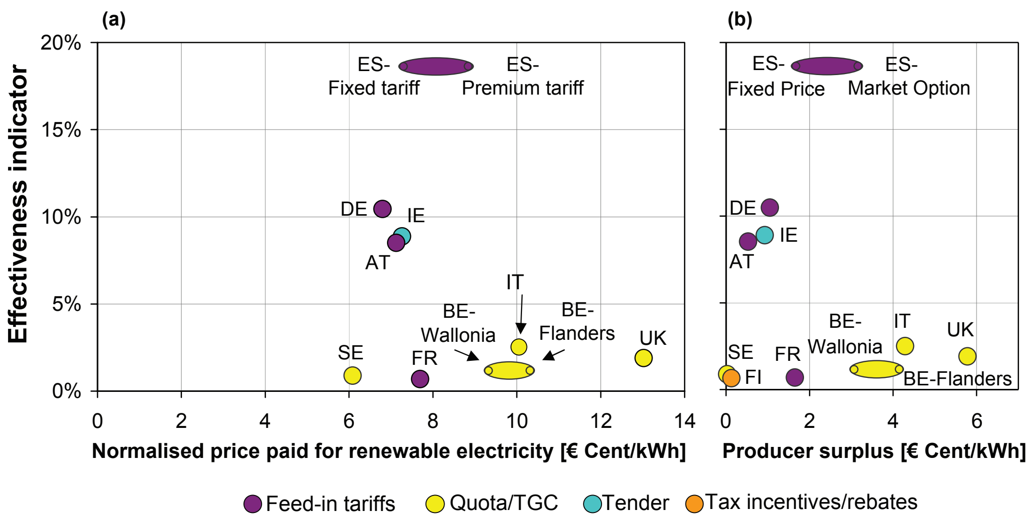


***Figure 2.*** *Cost and effectiveness of renewable support measures for on-shore wind projects in several European countries (1997–2004)*
*Source: Ragwitz et al., 2005*

## C.2. EU-Level Renewable Energy Support

European Union (EU) institutions have played an important but indirect role in RES-E support in Europe. Their principal contributions have included

- establishing EU-wide targets for RES-E development and apportioning these among individual member states;
- mandating the issue of guarantees of origin (GoOs) for use in power content disclosure and voluntary green power markets;
- urging member states to remove barriers to development of RES-E; and
- considering options for integrating and harmonising RES-E support mechanisms among different member states.

Each of these activities is discussed in more detail in subsections below.

The EU's role in RES-E development has been manifest principally in two "RES-E Directives." The first was passed by the European Parliament and Council (the EU's two legislative bodies) on 27 September 2001 (EU, 2001). This directive is referred to as the "2001 RES-E Directive" below. The second RES-E Directive was proposed by the European Council (the EU's executive arm) on 23 January 2008 (EC, 2008b), and then underwent substantial revision over the summer of 2008 in subcommittees of the EU Parliament, and in December 2008 at a European Union summit. A near-final version of this directive was passed by the European Parliament as part of its "Energy and Climate Package" on 17 December 2008 (EP, 2008). The 2008 RES-E Directive is expected to be passed by the European Council and enter into force in 2009 with few additional changes.

### C.2.1. Establishing and Enforcing National Targets

One of the most important tasks of EU institutions with respect to RES-E development has been to adopt EU-wide targets for RES-E development and apportion these targets among individual member states. This process began with the 2001 RES-E Directive, which sought to obtain 22% of the EU's electricity from RES-E by 2010 and set targets for individual member states ranging from 5.7% to 78.1% (including large hydropower). Member states were required to adopt "national indicative targets" and action plans by October 2002, showing how they would work toward the 2010 targets. These plans and intermediate targets were to be revisited every 5 years.

At an EU summit in March 2007, member states agreed to a Renewable Energy Roadmap that would obtain 20 percent of *all* energy (whether electricity or heat) from renewable sources; this was expected to correspond to around 34% RES-E in the electricity sector (Euractiv, 2008a; EC, 2007). The 2008 RES-E Directive codifies this plan and sets specific targets for each member state that are between 7 and 14% above 2005 levels. These targets are illustrated in Figure 3; each member states must increase its share of RES by at least 5.5%, plus an additional increment that is roughly proportional to its GDP per capita (Johnston et al., 2008).

Member states have been reluctant to authorize the EU to use strict measures to enforce RES-E targets. For example, the European Commission originally proposed that the 2008 RES-E Directive include fines for states that did not comply with their targets (EP, 2008). However, these were removed during negotiations among member states at the EU Summit in December 2008. The version that passed the European Parliament requires only that member states submit national action plans (NAPs) to the European Commission for approval, followed by progress reports every two years. However, the European Commission reserves the right to initiate legal proceedings against any member state whose action plan is deemed inadequate (Euractiv, 2008c).

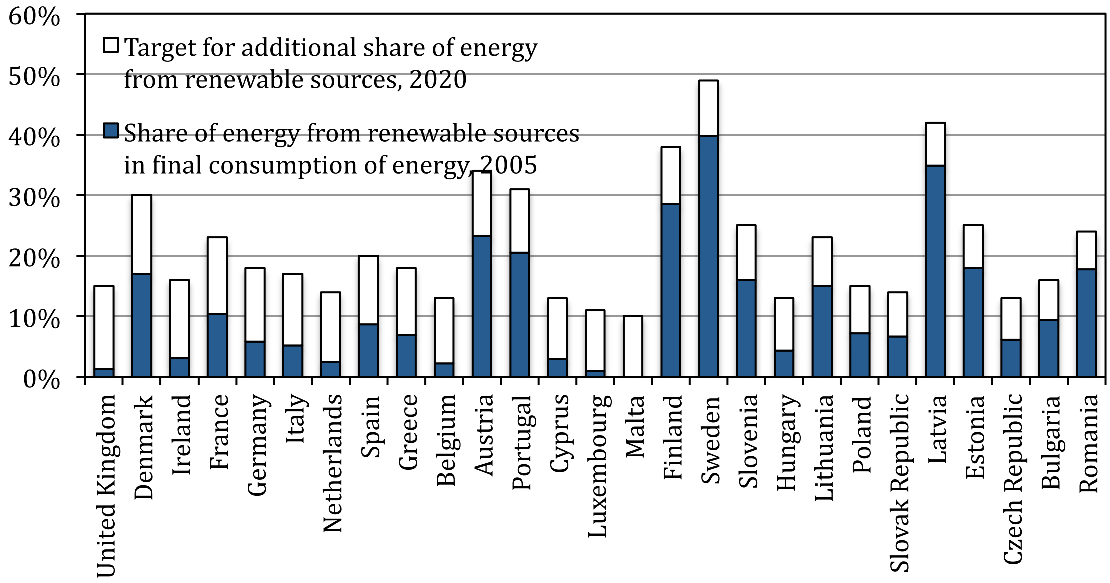


***Figure 3. Renewables targets for 2020, relative to existing capacity – EU Member States***
*Source: EC (2008b)*

### C.2.2. Guarantees of Origin of Renewable Power

The 2001 RES-E Directive introduced a new EU-wide instrument – guarantees of origin (GoOs) for electricity generated from renewable sources. A GoO shows the location, technology and time when a given of block power was produced from renewable sources. The purpose of these instruments is to allow power producers to demonstrate in a uniform manner that their power was derived from renewable sources. Under the 2001 RES-E Directive, each Member State was required to establish a system to issue these guarantees upon request by power producers.

The exact purpose of GoOs has been somewhat ambiguous. Their chief use has been to prove the origin of renewable power when disclosing the mix of fuels used by individual electricity providers. They have also been used for a similar purpose in voluntary markets for green power. For both of these purposes, the GoO plays a purely informational role, and is deemed to follow trades in electricity, rather than representing a separate, tradable good.

There has been some pressure to expand the role of GoOs, but this appears increasingly unlikely. In its January version of the 2008 RES-E Directive, the European Commission proposed that GoOs would take on an additional role as a tradable certificate for use in domestic or international RES-E quota systems. However, this new use could have conflicted with their role in disclosure of power content (AIB, 2008). The market system used in the EC's version of the 2008 RES-E Directive might also have run afoul of the EU's trade laws, and this uncertainty could have hamstrung a trading system based on GoOs (Euractiv, 2008b). Consequently, in the version of the 2008 RES-E Directive that passed the European Parliament in December 2008, GoOs were returned to their purely informational role.

The 2001 RES-E Directive did not specify how GoOs should interact with national systems of support for RES-E, nor did it recommend a system for redeeming GoOs to prevent their repeated use for multiple purposes. These concerns have been addressed by individual countries, through the use of "earmarks" and formal redemption systems. Earmarks identify whether the block of RES-E corresponding to a GoO has received public support, and/or whether it is eligible to be converted into a TGC. Redemption rules indicate when a GoO must be formally removed from circulation, e.g., at the moment when the RES-E receives public funds, or when the GoO is converted into a TGC. Table 2 shows the status of GoO mechanisms in the eight countries selected for special evaluation in this report.

Most of the national GoO registries are originally based on the Renewable Energy Certificate System (RECS International) (Coenraads, 2008b). RECS International was set up in 2001 as an industry association to experiment with GCs, establish standards and serve as an embryo for a future mandated European-wide certificate-based system (Muñoz et al., 2007). In most cases the GoO and RECS registries are combined into a single system. If the GoO is also available for the RECS system the GoO is 'flagged'. This opens the possibility to transfer a GoO to a RECS system (being non-GoO). It is not possible to transfer certificates from the RECS system into the GoO system.

Several EU countries have signed onto a standardised system of GoOs: the European Energy Certificate System (EECS). The system has been developed by RECS International and the Association of Issuing Bodies (AIB). EECS is based on harmonised structures and procedures, including a standard format for the interface between national registries, facilitating international trade in standardised GoOs without the danger of double counting and double selling. All governments in the EU that have chosen to regulate the voluntary green power market have opted for EECS standardised GoOs as the mandatory tracking mechanism for green electricity. Suppliers are forbidden by law to sell green electricity based on other tracking mechanisms. This facilitates exports and imports for the voluntary market, while effectively preventing double use (double counting, double selling) of one GoO at the same time. Voluntary markets for green power nevertheless remain fairly fragmented (Coenraads, 2008b).

In countries with TGC systems, there have generally been two treatments of GoOs:

- A free tradable GoO is given to the generator on top of the GC issued for the fulfilment of the obligation;
- The GoO is embedded in the GC itself, i.e. the GoO is redeemed after the issuance of the GC for the fulfilment of the quota obligation.

The systems in effect in each of the selected countries are discussed in Table 3.

***Table 2. Status of GoO Systems in the Selected Countries***

| ***Country*** | ***Legislation*** | ***Issuing body appointed?*** | | ***GoOs system in operation?*** | ***GoOs transferable*** | ***Redemption mechanism implemented*** | ***GoOs standardised according to EECS*** | ***Standard Unit*** | ***Validity of the GoOs*** | ***Earmarking* of the GoOs*** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ***Type*** | ***Name*** | | | | | | | |
| **Belgium, Flanders** | YES | Regulator | VREG | YES | YES | YES | YES | 1 MWh | 5 years | YES (for RECS) |
| **Belgium, Wallonia** | YES | Regulator | CWaPE | YES | YES | YES | PLANNED | 1 MWh | Until 31 December of following year. | YES(for financial support/not) |
| **Belgium, Brussels** | YES | Regulator | BRUGEL | YES | YES | NO | PLANNED | 1 MWh | Until 31 December of following year. | YES(for financial support/not) |
| **Italy** | YES | Electricity market operator | GSE | YES | YES, but only with the physical electricity | NO | NO | variable size | Not defined | NO |
| **Poland** | YES | Regulator | URE | YES | YES | NO | NO | variable size | Unlimited. | NO (GoOs can be used for fulfilment of the quota obligation - automatic redemption applies). |
| **Romania** | Under Preparation | Regulator | NARE | NO | N.A. | N.A. | NO | N.A. | N.A. | N.A. |
| **Sweden** | YES | TSO | Svenska Kraftnat | *Official GO*: YES | NO | NO | NO | variable size | Not defined | NO |
| | | | | *EECS GO*: YES | YES | YES | YES | 1 MWh | Unlimited (until redemption) | YES(financial support/not) |
| **The UK** | YES | Regulator | OFGEM | YES | YES | NO | NO | 1 kWh | N.A. | |

**Earmarking is used for indicating whether financial support and/or RECS have been awarded or not.*

***Table 3. Simultaneous use of GoOs and quota system in the Selected Countries***
*Source: Coenraads (2008b)*

| *Country* | *Remarks* |
|---|---|
| **Belgium, Flanders** | Certificates are earmarked whether they can be used for GoO (y/n) and whether they can be used as a GC under the quota obligation (y/n). If exported, a GC cannot be used anymore under the quota obligation in Flanders. |
| **Belgium, Wallonia** | GoOs are issued in coordination with GCs based on (i) unique measurement data, and (ii) a unique generation plant registry. GoOs and GCs are freely tradable independently from each other and from the electricity. A GoO may never be used to fulfil quota obligations and a GC may never be used for disclosure: *they are different instruments serving different purposes.* A GoO is used to inform the consumer of the quality of the electricity it consumes and a GC is used for encouraging RES-E generation. Exporting electricity has no impact on GoO or on GCs. |
| **Belgium, Brussels** | GoOs are issued in coordination with GCs based on (i) unique measurement data, and (ii) a unique generation plant registry. GoOs and GCs are freely tradable independently from each other and from the electricity. A GoO may never be used to fulfil quota obligations and a GC may never be used for disclosure: *they are different instruments serving different purposes.* A GoO is used to inform the consumer of the quality of the electricity it consumes and a GC is used for encouraging RES-E generation. Exporting electricity has no impact on GoO or on GCs. |
| **Poland** | GoOs are used to facilitate the administration of the quota obligation. Each company under the obligation has to submit a pre-defined amount of GoOs for redemption. Thus, the use of a GO is limited to either e.g. meeting the quota obligation or export. URE is responsible for the redemption. Imported GoOs cannot be used to fulfil the obligation. |
| **Sweden** | Sources eligible for El-Cert: GoO (in PDF format) may be issued as well. This GoO is not included in the EECS GO registry. Sources not eligible for El-Cert: electronic and transferable GoO in the EECS GoO system may be issued. |
| **The UK** | Both REGOs and ROCs (similar to GoOs and TGCs) are issued for the same unit of RES-E. REGO has earmark whether financial support has been received or not. |

*Romania and Italy are not listed as there have been no official clarifications in this respect.*

### C.2.3. Reducing Barriers to RES-E

The EU's 2001 and 2008 RES-E Directives have taken several steps to try to remove barriers to entry of RES-E projects. These include a requirement that Member States ensure that TSOs and DSOs in their territory guarantee the transmission and distribution of RES-E. New provisions in 2008 require the establishment of a single administrative body in each Member State to serve as a "one-stop shop" for licensing, certifying and providing support to RES-E projects, from the local to national level. Technical and legal requirements and deadlines must also be spelled out clearly and streamlined as much as possible. Additional provisions require Member States to expand grid infrastructure as needed to incorporate RES-E projects, and to share costs transparently and without discrimination among all users of the grid, rather than assigning them all to new entrants.

### C.2.4. Harmonising National RES-E Support Schemes

The EU institutions could in the future play an important role in pushing Europe toward a single, harmonised support system for RES-E. In 2001, 2005 and 2008, the European Commission formally considered adopting a harmonised system, but each time it deferred making a recommendation until a later date. The 2008 RES-E Directive includes some optional mechanisms that Member States can use to harmonise their own policies, if they desire. It also sets forth a plan to revisit this issue in 2012.

As will be discussed below, the EU has not moved far towards a harmonised system because of uncertainty about whether to adopt a FIT- or TGC-based system and because there are some advantages to maintaining the existing, heterogeneous system. The EU has instead opted to allow countries with similar RES-E support systems to cooperate, while urging each country to adopt the most optimal version of whatever system it has chosen. This may eventually lead to convergence on smaller number of better (and more consistent) RES-E support systems in Europe.

### C.2.4.1. TGCs or FITs?

Perhaps the most important barrier to the adoption of a harmonised EU-wide RES-E support scheme is the lack of consensus on whether such a system should use a quota system with TGCs, or a FIT-based approach. Much of the debate on this issue echoes the points already made in section C.1. For example, the Parliamentary rapporteur's statement on the 2008 RES-E Directive reported that,

> "the concept favoured by the large power producers (e.g. EURELECTRIC) and the traders of electricity (EFET) to bring legal certainty by creating an EU wide renewables certificate market is not the way forward. Such a scheme would not only undermine the existing national support schemes, but also potentially generate €30 billion in windfall profits for traders and generators by moving from the technology specific average price support schemes to a marginal market where the most expensive marginal renewable certificate would set the price. This would by far exceed the potential €8 billion 'flexibility' benefits identified in Commission's impact assessment." (EP, 2008, pp. 158-9)

Although FITs have performed better than TGC-based systems on a national level, their positions could be reversed on an EU-wide level. For example, it would be difficult to find an appropriate EU-wide level of feed-in tariff, without introducing windfall profits for regions with lower-cost electricity. One way out of this particular difficulty would be to harmonise the premium paid above market price for RES-E, rather than the exact price (Muñoz et al., 2007). But it would remain difficult to adopt a single FIT framework that correctly reflects the geographic and technological diversity of RES-E resources throughout the EU. On the other hand, TGC systems might benefit from the economies of scale and broader, more liquid markets that they would find on an EU-wide level. TGC systems are also appealing for countries such as Luxembourg, Malta, Austria, and the UK that would have difficulty meeting their targets at a low cost using domestic resources (Fouquet and Johansson, 2008; Poyry, 2008).

However, there are concerns that Member States would have no control over imports and exports to and from their countries or the effects of trade under an EU-wide TGC system (Klessmann et al., 2007). The introduction of such trade could yield annual producer rents approximately €30 billion higher than the costs of an EU-27-wide technology specific support (SEC, 2008). This in turn could encourage dominance by a small number of powerful electricity producers (Fouquet and Johansson, 2008; Toke, 2008). This would run counter to attempts that are being made to reduce industry concentration by auctioning (instead of granting) CO2-emission allowances to power companies (Ragwitz et al., 2007).

It remains difficult to conclude whether a FIT- or TGC-based system would work better at the EU-level. Theoretical analysis and simulation models indicate that a European-wide harmonised TGCs scheme for RES-E may lead to significant benefits for the promotion of RES-E in the EU both in terms of effectiveness and efficiency (Voogt and Uyterlinde, 2006). However, these results are highly sensitive to the assumptions made concerning e.g. the smooth functioning of the TGC market and its effect on the EU-wide TGC price, and the initial level of RES-E deployment. On the other hand, "The EU wide certificate market approach has been refuted by a number of academics, consumers (e.g. German Chemical Industry) and by a number of governments (e.g. Poland, Germany, Spain, Greece, France...)" (EP, 2008, pp. 158-9).

### *C.2.4.2. Disadvantages of EU-Wide Harmonisation*

The EU has also identified several advantages of maintaining the existing, heterogeneous system:

- imposing a new support system in place of existing mechanisms could disrupt progress that is already being made by national support systems and create policy uncertainty, hindering development of RES-E (EC, 2005b);
- many of the advantages of a harmonised system depend on harmonisation of electric markets and removal of support for conventional generators, process which have not yet been completed (EC, 2005b);
- maintaining a heterogeneous collection of support mechanisms makes it possible to wait and see which system works best; it also makes it possible to reap some of the benefits of each system, e.g., the low costs of a TGC system and the support for immature technologies given by a FIT system (EC, 2005b);
- different countries have different economic, social and environmental priorities, and a single support mechanism may not suit all their goals (Voogt and Uyterlinde, 2006; Del Rio, 2005);
- residents of one country may be reluctant to pay for RES-E that is manufactured elsewhere (Sawin, 2004); for example, the Netherlands scrapped an international tradable certificates system when three-quarters of the funds went abroad (Lauber, 2004);
- on the other hand, people may oppose the siting of RES-E projects near their homes if the project will be used to fulfil another country's RES-E quota (EC, 2005b);

### *C.2.4.3. Cooperation and Optimisation*

In light of these difficulties, the EU has decided to adopt a policy of "cooperation and optimisation" of RES-E policies among the member states – the EU will make it easy for states with similar support systems to coordinate their efforts, while at the same time urging each state to improve its policies as much as possible. Ultimately, this approach may lead to a convergence on one or two preferred systems for the whole EU, making later harmonisation of policies easier (EC, 2005b).

This approach is supported by the results of model-based prospective analyses, suggesting that the most significant efficiency gains can be achieved simply by strengthening and improving national support schemes (Ragwitz et al., 2005). According to these analyses more than two-thirds of the overall cost-reduction potential of policy harmonization can be attributed to the optimization of national support schemes.

In the realm of "cooperation," the 2008 RES-E Directive introduces several new rules that member states can (optionally) use to harmonise their policies on a sub-EU level:

- New, standardized Transfer Accounting Certificates (TACs) can be used to transfer incremental shares of RES-E quotas between Member States, to account for firm-to-firm transfers or jointly implemented projects; countries may optionally require prior authorisation for these exchanges, in order to maintain diversity in their mix of resources or achieve particular environmental goals; these transfers are not linked to physical flows of electricity, and this system could become the basis for a future EU-wide TGC system;

- Member States may agree to transfer part of their RES-E obligation to each other, or may pool their quotas into a single quota (presumably using a common support mechanism); and
- Member States can import electricity from RES-E projects outside the EU and apply it to their national target, provided the neighbouring country has "concrete national renewable energy and energy efficiency policy targets"; however, 'virtual' transfers of green electricity from outside the EU are not allowed.

The "optimisation" part of the EU's strategy has not been as clearly codified, but was originally described as including guidelines for many aspects of national policies: increasing policy stability within each country, streamlining administrative procedures, easing grid access for RES-E, encouraging diversity in the technologies developed, providing more tax incentives for RES-E, harmonising RES-E policies with electricity market liberalisation policies, encouraging local employment and other local and regional benefits, and pairing RES-E policies with support for energy efficiency and demand management (EC, 2005b).

## D. Carbon Mitigation in the EU

The main system for reducing greenhouse gas emissions in the EU region is the EU Greenhouse Gas Emission Trading Scheme (EU ETS). This system currently covers all electricity production and energy-intensive manufacturing. Air travel will be added in 2011 or 2012. The number of emission allowances available in this system will be 21% below 2005 levels by 2020. The goal of the system is to help the EU and its Member States to reach their short and long-term GHG targets (e.g., under the Kyoto Accord) in a cost-efficient way. Table 4 summarizes key information on EU ETS.

The key problems identified with respect to the EU ETS refer to (i) the substantial producer rents power companies realize because of the free allocation of the emission allowances, and (ii) the relatively low emissions reductions it achieves because of *inter alia* the reduced level of emission reductions provided in the National Allocation Plans (NAPs) and the high share of flexibility mechanisms companies can use.

***Table 4. Key Information on EU Emissions Trading System***

| Elements | Remarks |
|---|---|
| **Legal basis** | • EU Emissions Trading Directive 2003/87/EC<br>• National Allocation Plans (NAPs) determine country-specific design features. NAPs have to be approved by the EC. At *macro* level NAPs indicate the total quantity of allowances available in each period. At *micro* level NAPs indicate the allocation of allowances to installations. Thus, NAPs also determine the emission reductions expected from the sectors which are not covered by the EU ETS. |
| **Trading phases** | • Phase I: 2005-2007<br>• Phase II: 2008-2012 |
| **Type of system** | Cap and trade, downstream system which covers *absolute* emissions comprising the total emissions of the companies concerned. |
| **Sector coverage** | Power and heat generation; Glass and glass fibres; Mineral oil processing; Paper and pulp production; Coke ovens and metal processing; Cement, lime production, other building material and ceramics |
| **GHG coverage** | Only $CO_2$ emissions are included for now. These concern both emissions from combustion of fossil fuels and process-related emissions. |
| **Allocation of allowances** | • Phase I: free allocation with the possibility of auctioning of up to 5%*<br>• Phase II: auctioning of up to 10% of allowances |
| **Penalties** | €40 during the 2005-2007 for each tonne of excess emissions plus the restoration of excess tons in the following year |
| **Banking and borrowing** | Banking is allowed, while borrowing is not. |
| **Opt-in/Opt-out** | Opt-in is not allowed, opt-out is. |
| **Flexibility elements** | • A temporal exclusion of specific installations was allowed in 2005-2007;<br>• Installation pooling is allowed;<br>• MS may ask the EC to allocate additional allowances to specific installations in case of force majeure. |
| **Links with Kyoto mechanisms** | Credits generated under CDM, JI projects can be used for covering emissions under the EU ETS. Their use is limited to certain percentage mentioned in the NAPs. The use of the Kyoto mechanisms is supplemental to domestic action. |

**Only 4 out of the 25 EU states used auctions at all, and only Denmark fully employed this option.*
*Source: Morthorst et al. (2004), Cameron et al. (2006)*

In order to obtain the political support of large emitters, most $CO_2$ emission allowances are allocated for free under the EU ETS. However, this means that power companies realize substantial windfall profits (Sijm, 2006; Cameron, 2006). For example, in the Netherlands and Germany the $CO_2$ pass-through rates vary between 60 and 100% of $CO_2$ costs, depending on the carbon intensity of the marginal production unit and various other market or technology-specific factors. At a price of 20€/t$CO_2$ estimates of windfall profits due to the EU ETS in the Dutch power sector for an average, "representative" year vary between €300 and €600 million. The UK power sector profits from the EU ETS were estimated at £800m/yr (Sijm, 2006).

A comparison of the submitted NAPs with those approved by the EC suggests that the EC's decisions significantly improved the effectiveness and economic efficiency of the EU ETS. The EC has developed its own criteria based on 2005 verified emission data, economic growth and carbon intensity trends. By applying these criteria, the EC has requested budget cuts in all but two of the assessed NAPs (the UK and Slovenia). On average, the NAPs in phase II are only about 1% lower than historical emissions in 2005 and 2.1% lower than the budgets in phase I (2005-2007) as well as 2.4% lower than projected emissions in 2010. Thus, the intended allocation for the ET-sector in 2008-2012 would not require sharp reductions. Companies can also use flexibility mechanisms to meet a large share of their obligation, further easing the cuts they must make.

The EU ETS also imposes costs on other sectors. From a cost-efficiency perspective, with the exception of the UK and Spain, the sectors that are not covered by the EU ETS have to bear a disproportionately high share of the reduction efforts in all EU-15 Member States. As such, while EU ETS enables the sectors it covers to cost-efficiently achieve their emission targets, the economy as a whole pays a premium for giving a more generous share of the emissions budget to those sectors, rather than to other sectors whose emission reductions cost more (Schleich et al., 2007; Cameron et al., 2006).

From a legal perspective, the free allocation of allowances under the various NAPs involves an element of state aid, which has not been formally cleared by the European Commission under the EC Treaty. In contrast, auctioning of allowances would reduce the distortions associated with free allocation and be correspondingly more compatible with the EU state aid legislation (Cameron et al., 2006). Furthermore, as a form of state aid, the free allocation of permits may be incompatible with the EU principle of proportionality[2] (Johnston, 2006).

[2] This is the principle that EU institutions must take actions that are just sufficient to achieve their goals, and leave as much freedom as possible to member states and individuals.

# E. Interactions Among EU Energy Policies

The RES-E support schemes coexist with the EU ETS because of the three drivers of the EU energy policy: (i) low consumer costs, (ii) deployment of RE technologies and (iii) GHG emissions reductions. The combination of the two instruments is intended to deliver on RES-E goals and $CO_2$ reduction targets, while simultaneously minimizing customer costs. The coordination of the targets of the two instruments is essential. The increase in RES-E production should be matched by a decrease in the $CO_2$ targets for power generation. It should be noted that the results of the analysis of these interactions are sensitive to the design of the instruments in particular countries.

## E.1. Interaction between Carbon and Renewable Energy Policies

### E.1.1. Coexistence of Policies for Carbon Mitigation and Renewable Energy Support

The EU ETS is technologically neutral – it provides equal support to any technology that can reduce greenhouse gas emissions from the electricity sector. However, EU Member States desire to support the development of renewable energy technologies in general and in some cases specific renewable energy technologies. Consequently, they have adopted a combination of carbon mitigation policies and RES-E support schemes, in order to achieve these dual objectives.

Renewable energy technologies are generally high-cost $CO_2$ emissions mitigation alternatives[3] and EU ETS alone provides a positive but limited incentive to their deployment within the EU borders[4]. To incentivize RES-E deployment based solely on a high price for tradable $CO_2$ emissions allowances (TEAs), TEAs would have to cost 30-200 €/tCO2 (Reinaud, 2003). It would require a very ambitious $CO_2$ target to push TEA prices into this range. It should also be noted that the TEA price can also be reduced by the inclusion of the Kyoto Accord's Clean Development Mechanism (CDM) in the EU's carbon framework; this mechanism allows companies to invest in clean development projects in developing countries, in order to create offsets against EU-based greenhouse gas quotas. These cost-savings could further reduce the incentive for local development of RES-E. In addition, local RES-E benefits would not be captured within the EU borders if companies deploy renewables abroad (Del Rio et al., 2005b).

Although RES-E is generally too expensive to be supported based on the value of its $CO_2$ emission savings alone, EU countries have sought to support it in order to obtain other benefits. Chief among these are improvements in energy security, increasing rural employment, gaining a competitive advantage in a new, high-tech industry, and mitigating local pollution (Del Rio, 2007; Sawin, 2004; EC, 2005b). RES-E technologies are also evolving rapidly, with ongoing improvements in design and manufacturing techniques being funded by revenues from each generation of equipment. Consequently, support for RES-E now can be seen as an investment in a lower-cost GHG mitigation technology, which may be needed on a large scale in future years, when emission quotas are further tightened.

In order to secure these benefits, EU countries have generally adopted dual policies, simultaneously seeking to reduce greenhouse gas emissions in general and promote RES-E

[3] An exception is biomass-heat and co-firing which can be cost-competitive in certain countries.
[4] Project–based flexibility mechanisms and particularly the Clean Development Mechanism seem to provide an incentive for the international deployment of renewable energy. Approximately 130 registered projects were based on renewable energy out of a total of 228 registered CDM projects till July 2006 (Del Rio, 2007).

development in particular. This strategy is likely to continue in the future (Del Rio et al., 2005b; Morthorst, 2001; Huber and Morthorst, 2004).

The next two sections discuss how support for carbon emission reductions and RES-E can interact, and point out strategies for avoiding potential pitfalls due to these interactions.

### E.1.2. Markets for Carbon and Renewable Energy

This section focuses on the possible interactions between tradable allowances for GHG emission reductions (TEAs), tradable green certificates (TGCs) for RES-E, and electricity in a liberalised market. TEAs and can TGCs interact at either national or international levels because of their common goal of reducing $CO_2$ emissions. This interaction occurs mainly by way of electricity market prices.

Three possibilities have generally been considered for linking the TGC and TEA markets – full fungibility, one-way fungibility and complete separation. The latter option has been indicated as being most suitable (Sorrel, 2003a, b). This option is also employed by the EU, as $CO_2$ credits are kept entirely separate from TGCs. Table 5 summarizes the three options and their implications.

***Table 5. Implications of full or partial fungibility between TGCs and TEAs***

| *Options* | *Concepts* | *Implications* |
|---|---|---|
| ***Full fungibility*** | TGCs can be used to comply with $CO_2$ targets and vice versa. | • Difficulty in complying with RES-E quota as RES-E is relatively expensive as a $CO_2$ emissions reduction alternative;<br>• Difficulty in calculating the $CO_2$ emissions reduction caused by the displacement of conventional electricity by RES-E and therefore double crediting issues might arise;<br>• Significant transaction costs;<br>• Local benefits of RES-E are not considered. |
| ***One-way fungibility*** | Following compliance with RES-E quota, additional TGCs can be transformed into TEAs. | • Difficulty in calculating the $CO_2$ emissions reduction caused by the displacement of conventional electricity by RES-E ;<br>• Double crediting is possible as an increase in the RES-E generation attracts both TGCs and TEAs. |
| ***Complete separation*** | One currency cannot be used for compliance with the other quota. . | • The $CO_2$ and the non-$CO_2$ values of RES-E are independently traded in the TEA and the TGC market. |

### E.1.3. Coordination of Targets for Carbon and Renewable Energy

$CO_2$ restrictions make RES-E deployment more competitive as they increase the costs of conventional electricity. On the other hand, RES-E deployment reduces the demand for conventional electricity and consequently the demand for TEAs. The TEAs price is thus reduced. Therefore, the conventional electricity generation costs are diminished. Nevertheless, the customers experience additional costs because of the quota support scheme based on TGCs.

At least two studies suggest that it is ambiguous whether the additional cost of TGCs will be larger than the saved cost for TEAs; they each found that under certain conditions the combination of a TGC and TEA system could yield lower average power costs than a system that achieved the same $CO_2$ target with TEAs alone. Rathmann (2006) estimated that the fee to support RES-E under the German FIT increased the system-wide cost of electricity by 3.8

€/MWh in the years 2005-2007. However, the RES-E generated by these systems displaced conventional power from the grid, reducing the need for TEAs, and decreasing the average cost of electricity by 6.4 €/MWh. Thus, without the RES-E support, the system-wide average cost of electricity would have been 2.6 €/MWh higher than it actually was.[5] Jensen and Skytte (2003) found similar behaviour in a more hypothetical example, depending on how tight the GHG quota was compared to the RES-E quota.

These are special cases, but they do point to a more general phenomenon – that tightening an RES-E quota will tend to displace GHG-emitting power from the system, reducing the cost of TEAs. This can lower the cost of electricity, but it can also generate additional profits for owners of conventional generators, and/or lead to an increase in GHG emissions from conventional generators. Consequently, an increase in the RES-E quota should be matched with a decrease in the $CO_2$ target. Unfortunately, it is generally unclear how much $CO_2$ reduction an additional amount of RES-E will create. This must be estimated in order to make a precise adjustment to the emission reduction target (Huber and Morthorst, 2004; Skytte, 2006).

The interaction between the two instruments at national level is summarized in Figure 4.

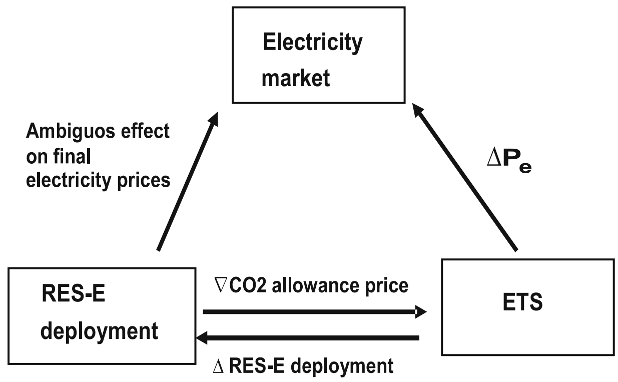


***Figure 4. Summary of interactions between electricity, GHG and RES-E markets***
*Source: Del Rio (2007)*

An additional interaction concerns the effect of RES-E quotas on the supply of electricity in general, and consequently the wholesale price of electricity. Sorrel (2003b) studied the interactions between the EU ETS and the UK quota system based on TGCs. He distinguished between direct and indirect interactions.

No *direct interactions* exist between the two instruments in the UK. The quota system targets electricity suppliers while the EU ETS targets electricity generators and large industrial consumers. Hence the same company may be involved in both the quota system and the EU ETS but not simultaneously for the same installation.

The *indirect interactions* are considered significant, however. The most relevant is the impact on consumer prices, which is deemed ambiguous. The RES-E quota system expands the supply of electricity, and might reduce wholesale electricity prices if demand is relatively static. Simultaneously, electricity suppliers would have to incur additional RES-E costs that would be passed further onto the consumers. The two effects offset each other and might lead to higher or lower costs for consumers and electricity suppliers, at least in the short term. The study concludes that, in practice, higher costs are more likely and that the UK government expects the quota support system to increase average consumer electricity prices by 4.4% by 2010.

[5] It should be noted that these findings depend sensitively on assumptions about the supply curve for TEAs; in this study, the subsidised RES-E was able to reduce the (relatively small) shortfall of ETS permits in Germany by about 27%, which was assumed to yield a 27% decrease in the marginal cost of TEAs.

## E.2. International Interactions between National Environmental Policies

The second category of interactions in the EU context pertains to the possible effects of international trading of electricity, TGCs or TEAs on national environmental goals.

Table 6 summarizes the possible outcomes for three different degrees of international integration of these markets, based on studies by Morthorst, (2001, 2003a, b). In all three cases, there is an international market for electricity, and domestic targets for RES-E development and GHG emission reductions. It is also assumed that TGCs are not tied to corresponding TEAs. This example describes interactions between separate countries, but it could apply equally well to states or provinces within a single country that have a common electricity market and separate RES-E and GHG policies.

In the first case, electricity can be traded internationally but there is no international market in TGCs or TEAs. Under these conditions, there is a risk that countries with more ambitious RES-E goals will end up subsidising their neighbours' GHG emission reductions. This is because neighbouring countries can shut down their own carbon-intensive power plants (reducing their own GHG emissions) and instead import power from the more environmentally ambitious country. So any funds spent to increase the share of RES-E generated in the more ambitious country could to some extend subsidise the sale of clean power to the neighbouring country. The neighbour can "free ride" on the RES-E policy of the more ambitious country in order to achieve its own $CO_2$ reductions at a lower cost.

In the second case, an international TGC market is developed in addition to the international electricity market. This case potentially introduces more severe free-rider problems. As before, the RES-E produced by both countries helps both countries to achieve their GHG goals, so that the country with a stricter RES-E target ends up paying for a disproportionate share of both countries' GHG reductions. However, in this case, the country with stricter RES-E targets will also end up paying for some RES-E development in the less strict country, by way of the TGC mechanism.[6] This will help achieve both countries' RES-E goals, but the local benefits of this portion of the RES-E expenditure (e.g., rural employment, pollution abatement) will be captured by the country with the less-strict RES-E target, at the expense of the country with the stricter RES-E target.

In a final case, the two countries allow liberalised trade of TEAs across borders (e.g., under EU ETS), in addition to international trade of TGCs and electricity. In this case, if the more environmentally ambitious country increases its RES-E target and simultaneously reduces its GHG emission quota by a corresponding amount, it will induce the development of just enough RES-E to generate the desired GHG reductions. Then, any additional funds spent on RES-E development will contribute to achieving the stricter country's new GHG target, rather than spilling over and assisting the neighbour in meeting its GHG target.[7] Put another way, if RES-E and GHG targets are carefully coordinated on a national level and there are liberalised international markets for TGCs and TEAs, then the cost of TGCs and TEAs will tend to reflect their respective benefits: the cost of TEAs will reflect the marginal cost of GHG emission reductions, while the cost of TGCs will reflect the additional cost of developing RES-E, over and above the value of the GHG emission reductions. Thus the country buying the TGCs will not pay for the $CO_2$ emissions reduced in the country of deployment. A coordinated tightening of GHG and RES-E quotas in the stricter country will cause an appropriate amount of additional

[6] This scenario assumes implicitly that the country with a "stricter RES-E policy," has a higher marginal cost of compliance, so it will become a net import of TGCs if that is possible.
[7] The location-specific benefits of the RES-E policy may, however, still spill over to the neighbouring country.

expenditure on TGCs and TEAs, and this additional expenditure will contribute directly to achieving each of the desired goals.

The introduction of a TEAs market in a liberalised conventional electricity market may improve the performance of a TGC market with regard to national $CO_2$ emissions reductions. The coordination of the two instruments is essential. An increase in the RES-E quota should correspond to a decrease in the CO2-reduction target.

To summarize, in a liberalised conventional electricity market without TEA trading, the most ambitious countries in developing RES-E capacity would only partially benefit from the GHG emissions achieved while incurring increased RES-E costs. These countries could end up buying TGCs from less ambitious ones to fulfil their national RES-E development target. Under this scenario, no additional GHG reductions are achieved through the initiative at the TGC market. GHG emissions are reduced but only to the level of the emissions quotas. Thus the ambitious countries will support the less ambitious ones in achieving their GHG-reduction targets. However, a close coordination of the two instruments can ensure the benefit of the additional GHG emissions reductions to countries that deploy RES-E technologies most ambitiously. To this end, when the RES-E production is increased, the GHG quota should be reduced.

***Table 6. Implications of combining international trade of electricity with TGCs and/or TEAs***

| ***Case*** | ***Inter-national electri-city trade*** | ***Inter-national TGC trade*** | ***Inter-national $CO_2$ (TEA) trade*** | ***Outcome*** |
|---|---|---|---|---|
| 1. | √ | | | Countries with ambitious RES-E goals subsidize $CO_2$ reductions in the countries less ambitious. |
| 2. | √ | √ | | Countries with ambitious RES-E goals subsidize $CO_2$ reductions and RES-E deployment in the countries less ambitious. |
| 3. | √ | √ | √ | Countries with ambitious RES-E goals can benefit most from the $CO_2$ reductions thus achieved if the $CO_2$ reduction target is closely coordinated with the RES-E target. International TGC trade would be encouraged. TGC price corresponds to the additional cost of RES-E deployment. The $CO_2$ reduction value is included in the price of the TEA traded under EU ETS. |

## F. Conclusions

The European Union (EU) is in the midst of a long-term experiment with support for renewable electricity (RES-E) whose outcome remains uncertain. The EU has adopted rising targets for the deployment of RES-E in recent years, but it has yet become clear what is the best way to encourage investors to move toward these targets.

There are two leading contenders for this role: Quota-based systems rely on the exchange of "tradable green certificates" (TGCs) from RES-E projects to meet a national target at the lowest cost. Feed-in tariff (FIT) systems provide a guaranteed purchase price for power from RES-E projects (or a guaranteed premium of the market value of electricity). TGC systems have strong intellectual appeal – they can in principle deliver RES-E at the lowest cost, with minimal government intervention other than setting the overall quota. FIT systems have the advantage of being more easily tailored to support specific RES-E technologies or sites without paying unnecessary premiums to lower-cost projects, and they provide a greater degree of certainty to RES-E project investors. However, FIT systems require more painstaking policy design, to avoid over-subsidising RES-E projects. So far, FIT system planners appear to have been able to manage this, inducing greater development of RES-E at a lower cost than the TGC systems used elsewhere.

On an EU-wide scale, the investment uncertainty of TGCs could be mitigated by a more stable, broad-based policy environment, and the problems in getting TGC markets off the ground in individual countries could be alleviated by access to a single, large market. On the other hand, the establishment of appropriate FITs for different technologies and locations could become more contentious in the wider EU environment than it is on a national level. Consequently, neither FITs nor TGCs are a clear choice for a single EU wide policy.

Although the experience in the EU to-date does not reveal an obvious, best way forward for RES-E support, it can still teach some useful lessons:

- Support for RES-E development may well be needed even if there is a strong system in place for greenhouse gas (GHG) emission reductions; using dual systems allows society to take advantage of other benefits of RES-E, and to prepare for an era of steeper GHG emission reductions in the future;
- RES-E and GHG policies should be coordinated in order to avoid negative spillovers between policies; these could include funding for RES-E projects that fail to reduce GHG emissions, or that allow other countries to free-ride on one country's support for RES-E;
- TGC and FIT systems can successfully coexist in neighboring regions, and the benefits of harmonising them may not exceed the benefits of maintaining the status quo;
- Care should be taken when developing RES-E support mechanisms to avoid double-counting amid a proliferation of instruments; this remains an unclear issue in Europe – for example, if TGCs from a RES-E project are delivered to one electricity supplier, but the physical electricity is delivered to a customer served by another supplier, it would appear that the customer's power label would show green electricity, even though the "green-ness" was paid for under another company's quota obligation; this issue will need further attention as the European policy framework evolves; and
- Creating certainty about investor revenues (or finding alternative sources of capital) may be one of the most important aspects of any successful RES-E support policy; this appears to be the main reason for the relatively strong performance of FITs despite the theoretical advantages of TGCs.

# G. Background Data on Selected Countries

## G.1. Belgium

Belgium is divided into three administrative regions: Flanders, Brussels and the Walloon region. Each of these implements the national energy policies separately. The result is different support conditions in each of the three regions. Additionally, support at federal level is being offered.

**Main promotion scheme** A green certificate system with mandatory demand and guaranteed minimum prices ("fall-back prices") for green certificates at *federal* level. Each of the three regions has developed its own green certificates markets.

**Obligatees:** Electricity suppliers.

**GoOs:** Will support the voluntary market. Import of certificates for the market is not possible.

**Additional support** Investment support is available, especially for PV.

**Status of RES-E market** Still an immature RES-E market due to policy change in 2002 and due to small size of the regional certificate markets.

**Main barriers** Because of (i) the possibility of banking of certificates, (ii) formerly increasing penalty rates, and (iii) a shortage on certificates, not much trading has taken place. It is more favourable to pay penalties the first year and use the certificates in later periods. Due to the division by regions the Belgium market is not fully transparent. Furthermore, the markets are rather small, resulting in an illiquid market with little trade.

<table>
<tr><th colspan="2">Level</th><th colspan="2">Federal</th><th>Wal-loon</th><th>Flan-ders</th><th>Brus-sels</th><th>Comments</th></tr>
<tr><td rowspan="4">Targets (final consumption)</td><td rowspan="2">RES-E</td><td>By 2010</td><td>6%</td><td rowspan="2">7% (RES-E and CHP) by 2007</td><td rowspan="2">6% RES-E by 2010</td><td rowspan="2">2.5% by 2006</td><td rowspan="2">With an RES-E share of 2.98% in 2006 the national target of 6% is still far away. Wallonia is on track to meet its target set at national level (EREC, 2008).</td></tr>
<tr><td>By 2020*</td><td>13%</td></tr>
<tr><td rowspan="2">Bio-fuels</td><td>By 2010</td><td>5.75%</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">• Tax reductions are being contemplated. The approval of the European Commission of the levels of tax reductions is still pending.<br>• Currently, there is no significant biodiesel or bioethanol consumption in Belgium (the share of biofuels in the transport sector in 2006 was 0.01% (EREC, 2008)).</td></tr>
<tr><td>By 2020*</td><td>10%</td></tr>
</table>

| Level | | Federal | Wal-loon | Flan-ders | Brus-sels | Comments |
|---|---|---|---|---|---|---|
| **Duration (years)** | | | 10 | 10 | | RES-E producers are guaranteed to be issued certificates for 10 years as of start of operation although the RES-E targets are as yet not guaranteed past 2010. |
| **Minimum Prices** (fixed) €/MWh** | **Wind offshore** | 90 | N.A. | N.A. | N.A. | |
| | **Wind onshore** | 50 | 65 all RES-E | 80 | | |
| | **Solar** | 150 | | 450 | | |
| | **Bio-mass & other RES** | 20 | | 80 | | |
| | **Hydro** | 50 | | 95 | | |
| **Penalties €/MWh** | | | €100 for the years 2005-2007 | €125 for the years 2005-2007 | €75 for 2005-2006, increa-sing to €100 for 2007-2010 | |

**Represents proposed binding target.*
***TSO (federal level) and DSO (regional level)*

**Trading:**

| *GCs* | *With GoOs* | | *Without GoOs* | |
|---|---|---|---|---|
| | *January 2007 (overall)* | *4th February 2008* | *January 2007 (overall)* | *4th February 2008* |
| ***Quantity*** | 45,383 | 9,194 | 45,743 | 1,615 |
| ***Average Price (€/MWh)*** | 108.24 | 110.81 | 108.99 | 108.58 |

*Source: EREC (2008)*

**Walloon:**

| *GCs* | *3rd quarter of 2007* | *4th quarter of 2008* |
|---|---|---|
| ***Quantity*** | 227,009 | 154,087 |
| ***Average Price (€/MWh)*** | 91.46 | 88.16 |

*Source: CWAPE (Commission Wallonne pour l'Energie)*

## G.2. Italy

As of end of 2007 a series of new provisions regulating renewables in Italy came into force. They introduce *inter alia* technology-specific "banding" into the certificate system following the UK model. Additionally, small generators (up to 1 MWh) have the choice between selling their GCs on the market and receiving FIT (EREC, 2008).

**Main promotion scheme** Quota obligation (based on TGCs) as of 2001. The quota was set initially at 2%, with an increase of 0.35% per year till 2006. As of 2007 the quota will be increased by 0.75% per year 2012. In 2012 the government will decide upon a new annual percentage increase. TGCs are issued for all (new) RES-E (incl. large Hydro and MSW).

**Obligatees:** Electricity producers and importers. At national level, electricity suppliers have an obligation to supply a certain percentage of renewable electricity onto the market each year.

**GoOs:** Are issued in addition to GCs. GoOs are not linked to the national GC system.

| Years | | 2010 | 2020* | 2001-2003 | 2004 | 2005 | 2006 | 2007-2012 |
|---|---|---|---|---|---|---|---|---|
| Targets (final consump-tion) | RES-E | 25% | 17% | 2% | 2.35% | 2.7% | 3.5% | Increasing by 0.75% per year till 2012. |
| | Biofuels | 5.75% | 10% | | | | | |
| Duration (years) | | | | 8 | 8 | 8 | 12 | 15 |
| Value of certificates (€/MWh) | | | | | 93.8 | | | 130 (2007) |
| Default energy value of certificates (MWh) | | | | 50 | 50 | 50 | 50 | 1** |

**Represents proposed binding target.*
***Small plants (up to 1MWh) can choose between being granted GCs or receiving FIT for 15 years.*

**Additional support** Feed-in tariffs for PV for 20 years. Tariffs vary according to the capacity of the plant and its location, with values for 2007 ranging between 40-49€/MWh.

**Status of RES-E market** The quota system is still rather immature. The interim targets of the quota obligation set by the national government have not been reached. Among the new renewables in the electricity sector only wind energy and biowaste have shown relevant growth rates in the recent years. The share of RES-E in the total electricity consumption was of about 16.6% in 2006 (EREC, 2008).

**Main barriers** May include (i) authorisation process at the local level, (ii) high risk level for investors, and (iii) high grid connection costs.

## G.3. Poland

The energy sector in Poland is still dominated by hard coal and lignite industries. Hydropower and biomass are seen as the renewable with the greatest potential.

**Main support scheme:** Quota system based on TGCs implemented as of end of 2005. In 2007 the quota was 4.8%. For 2010-2014 it is set at 10.4%.

**Obligatees**: Electricity suppliers.

**Additional support:** Excise duty exemption.

<table>
<tr><th colspan="2">Years</th><th>2010</th><th>2020*</th><th>Comments</th></tr>
<tr><td rowspan="2">Targets (final consump-tion)</td><td>RES-E (%)</td><td>7.5</td><td>15</td><td></td></tr>
<tr><td>Biofuels (%)</td><td>5.75</td><td>10</td><td></td></tr>
<tr><td colspan="2">Penalties</td><td colspan="3">Failure to comply with the quota results in the application of a “compensation fee”. In 2005 an insufficient enforcement of these fees was noticed (EREC, 2008; Ragwitz, 2005).</td></tr>
</table>

## G.4. Romania

Romania adopted a quota system based on TGCs in 2004. Currently, the Romanian Parliament is about to pass new legislation for the promotion of RES. The introduction of technology "banding" is envisaged (e.g. wind energy producers will receive two GCs per 1MWh till 2015, and one GC after 2016).

**Main promotion scheme:** Quota system based on TGCs as of 2004, gradually increasing from 0.7% in 2005, 5.26% in 2008, 8.3% for 2010-2012. TGCs are issued to electricity production from wind, solar, biomass or hydro power plants with less than 10 MW capacity operated or modernized as of 2004.

**Obligatees**: Electricity suppliers.

**GoOs**: Have been introduced, being administered by the National Authority for the Regulation of Energy.

**Additional support:** Excise exemption for biofuels; accelerated depreciation of investments; fixed feed-in tariff for autonomous small wind systems up to 110-130€/MWh possible.

**Status of the RES market:** Due to the significant natural resources of the country, the deployment of RES does not seem to represent a primary concern. Currently, about one-third of the total electricity is supplied by hydropower. No other RES technologies have been deployed so far. Nevertheless, significant investments in wind energy have been announced and are in their project phase.

**Main barriers:** Include long administrative procedures, inability of the GCs system per se to secure the investors' confidence, the targets are not high enough considering the country's hydro potential.

<table>
<tr><th colspan="2">Years</th><th>2010</th><th>2020*</th><th>Comments</th></tr>
<tr><td rowspan="2">Targets (final con-sump-tion)</td><td>RES-E (%)</td><td>33</td><td>24</td><td>The draft proposal of the law for the promotion of RES indicates 33% for 2010, 35% for 2015, and 38% for 2020. In reaching these targets, the electricity produced by hydro plants of more than 10 MW are being counted.</td></tr>
<tr><td>Biofuels (%)</td><td>5.75</td><td>10</td><td>No significant consumption of biofuels so far.</td></tr>
<tr><td colspan="2">Duration (years)</td><td></td><td></td><td>The draft proposal of the law for the promotion of RES indicates 15 years for new plants, as of commencement of operation, but not later than 2014.</td></tr>
<tr><td colspan="2">Value of certificates (€/MWh)</td><td colspan="2">For 2005-2012 the annual minimum and maximum value is 24-42€/TGC.</td><td>The draft proposal of the law for the promotion of RES proposes a minimum of 27€/TGC, and a maximum of 55€/TGC for 2008-2014</td></tr>
<tr><td colspan="2">Penalties</td><td colspan="2">As of 1 January 2008, failure in meeting the quota results in payment of the double of the maximum price.</td><td>The sums thus raised are used for (i) either acquiring the surplus TGCs at the minimum price to be subsequently used during the years when demand exceeds the offer, or (ii) redistributing towards RES-E producers depending on the number of GCs sold and the technology used.</td></tr>
</table>

**Represents proposed binding target.*

## G.5. Sweden

**Main promotion scheme** Fluctuating quota obligation (based on TGC) as of 2003. It is extended till 2030. The obligation is incumbent upon (i) electricity suppliers, (ii) electricity users using electricity they produce/import/purchase on the Nordic Power Exchange, and (iii) users in electricity intensive companies. The quota fluctuations correspond to the planned phasing out of some plants.

**Additional support** Investment incentives of 15% for wind power. During a transition period, the certificate trading scheme will be complemented by targeted support for wind power production in the form of environmental bonus (13-19€/MWh) for wind energy in 2004. This will be progressively phased out by 2009. The environmental tax benefits can make some biomass CHP systems competitive.

| Years | | 2010 | 2020* | 2003 | 2008 | 2010 | 2012 | 2013 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Targets (final consump-tion) | RES-E (%) | 60** | 49 | 7.4 | 16.3 | 17.9 | 17.9 | 8.9 | 11.3 |
| | Bio-fuels (%) | 5.75 | 10 | | | | | | |
| Duration (years) | | As of 2007, power plants are entitled to certificates for maximum 15 years. | | | | | | | |
| Value of certificates (€/MWh) | | | | | 29-31 | | | | |
| | | No minimum or maximum set by the law. It depends on the market. The current prices are considered insufficient to initiate significant investments into new capacities. | | | | | | | |
| Penalties | | Defined annually by the Swedish Energy Agency. | | | | | | | |

**Represents proposed binding target.*
***The Swedish Parliament amended the target to 51%.*

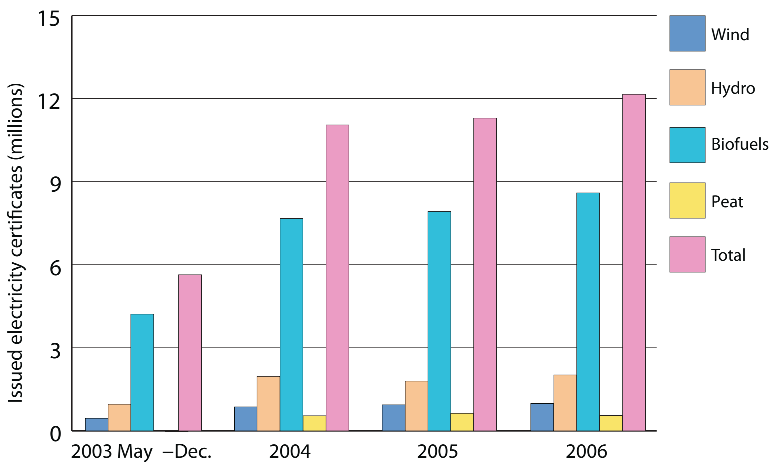


***Figure 5. Number of electricity certificates issued by types of energy source (2003-2006)***

| | |
|---|---|
| **Status of RES-E market** | As the certificate system is in its start-up phase, the effects are as yet difficult to assess. Currently, renewables cover approximately 38% of the Swedish total electricity consumption. This supply is covered mainly by *hydro power*. The use of *biomass* has increased substantially over the past decade, but this growth is mainly based on biomass co-firing, which can be profitable in the present quota system. New investments in biomass generation capacity are limited. *Wind capacity* installed in Sweden is relatively low although the wind resource in the south of the country is comparable to Denmark. |
| **Main barriers** | The low penalty level leads to the fulfilment of the quota through buy-out. The Government has declared that in the (near) future the certificate system may be opened for import. This market opening may pose a threat for investments in renewables in Sweden if a level playing field with the relevant import country (Norway) is lacking. |

## G.6. The UK

The UK Government announced in mid October 2008 its commitment to 80% emissions cut and the introduction of FIT allowing small-scale energy producers – such as homes with wind turbines or solar panels – to sell electricity at a guaranteed price (The Guardian, 2008).

Electricity suppliers in the UK may choose whether or not to meet their RES-E quota. They can 'buy-out' of their obligation by paying a fixed sum for each MWh for which they cannot present a TGC (known as a Renewable Obligation Certificate or ROC in the UK). This cost can be passed on to customers. The money thus collected by OFGEM (the UK gas and electricity market regulator) is then returned to all parties who present ROCs to OFGEM during the same period. For example, if a supplier presents 5% of all the ROCs presented in one year, then that supplier would receive 5% of the buy-out fund for that year (Mitchell et al., 2006). Therefore, in the UK the market price of ROCs can be higher than the buyout price due to the system of recycle payments; it has typically been equal to the sum of the buyout cost and the recycle payment (Ragwitz et al., 2005) The level of the recycled funds and consequently the ROC price would fall if the target were met.

**Main promotion scheme**: Quota obligation (based on TGCs/ROCs) for all RES-E as of April 2002. The quota increases gradually up to 15.4% in 2015. The system is guaranteed until at least March 2027.

**Obligatees:** Electricity suppliers.

<table>
<tr><th colspan="2">Years</th><th>2002-03</th><th>2007-08</th><th>2010</th><th>2015</th><th>2020*</th><th>Comments</th></tr>
<tr><td rowspan="2">Targets (gross final consump-tion)</td><td>RES-E (%)</td><td>3</td><td>7.9</td><td>10.4</td><td>15.4</td><td>15</td><td>From 2016, the UK Government aspires to increase the obligation level to 20% on a guaranteed headroom basis.</td></tr>
<tr><td>Bio-fuels (%)</td><td></td><td>1.7</td><td>3.5</td><td></td><td></td><td>Biodiesel and bioethanol have partial tax exemption, but not high enough to stimulate a young market. A Renewable Transport Fuel Obligation was introduced in April 2008.</td></tr>
<tr><td colspan="2">Duration (years)</td><td colspan="6">Until 2009 one ROC per MWh is issued to the operator of an accredited generating station with no time limitations. As of 2009, "banding" is intended to be introduced to award more or less than one ROC per MWh depending on technology type and its stage of development.</td></tr>
<tr><td colspan="2">Value of certificates (€/MWh) (buy-out + recycle)</td><td>66.61</td><td>Not yet known.</td><td colspan="2"></td><td rowspan="3"></td><td rowspan="3">The actual certificate price is typically higher than the buyout price due to the system of recycle payments.</td></tr>
<tr><td colspan="2">Buy-Out</td><td>43.50</td><td>49.74</td><td colspan="2">Increases in line with retail price index.</td></tr>
<tr><td colspan="2">Recycle</td><td>15.94</td><td>Not yet known.</td><td colspan="2"></td></tr>
</table>

*****Represents proposed binding target.*

**GoOs** Are issued by Ofgem (the British gas and electricity regulator) upon request from the producer.

| | |
|---|---|
| **Auctions** | Are being held quarterly. In January 2008 less than 65,000 ROCs were purchased at an average price of £49.95. The lowest ever average price for ROCs traded via the quarterly auction was £38.42 in January 2006; the highest was £52.07 in July 2004. |
| **Additional support** | Eligible RES-E are exempt from the Climate Change Levy certified by Levy Exemption Certificates (LEC's)[8], which cannot be separately traded from physical electricity. The 2004 levy rate was 4.3£/MWh (6.3€/MWh). Investment grants in the frame of different programs are being granted (e.g. Clear Skies Scheme, DTI´s Offshore Wind Capital Grant Scheme, the Energy Crops Scheme, Major PV Demonstration Program and the Scottish Community Renewable Initiative). |
| **Status of RES-E market** | The UK RES market is probably the most mature market among the countries with quota obligations in Europe. Its relative success is partially based on the fact that buy-out revenues for non-compliance are recycled to the suppliers in proportion to the certificates they have used for complying with the obligation. This mechanism increased the certificate price above the buy-out price because the market is short. High prices in the first year gave the ROCs market a kick- start. Compared to other quota systems the UK system provides a higher long-term security for achieving targets and for renewable energy investors. |
| **Main barriers** | Grid connection issues and grid capacities as well as severe competition on the electricity market disadvantage RES despite of the support programs. |

[8] Consequently, a producer can receive three certificates: ROCs, Levy Exemption Certificates (LECs) from the CCL and guarantees of origin (REGOs).

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