Can the future EU ETS support wind energy investments?

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Abstract

This article discusses how the future Emissions Trading Scheme legislation should be designed to allow the European Union to comply with the 20% greenhouse gas emissions reduction target, while at the same time promoting wind energy investments. We examine whether CO\textsubscript{2} prices could eventually replace the existing support schemes for wind and if they adequately capture its benefits. The analysis also looks at the effectiveness of the Clean Development and Joint Implementation mechanisms to trigger wind projects and technology transfer in developing countries. We find out that climate policy is unlikely to provide sufficient incentives to promote wind power, and that other policies should be used to internalize the societal benefits that accrue from deploying this technology: CO\textsubscript{2} prices can only reflect the beneficial impact of wind on climate change but not its contribution to the security of supply or employment creation. A minimum price of around €40/CO\textsubscript{2} should be attained to maintain present support levels for wind and this excludes income risks and intermediation costs. Finally, CDM improves the return rate of wind energy projects in third countries, but it is the local institutional framework and the long term stability of the CO\textsubscript{2} markets which matters the most.

Key words: Emissions Trading Scheme; wind energy; support mechanisms; CO\textsubscript{2} markets; CDM

1. Introduction

Following the agreement reached in March this year by the Heads of State (Council of the EU, 2007a), the European Union has committed itself to achieving, by 2020, that 20% of the energy it consumes comes from renewables and that its CO\textsubscript{2} emissions are cut by 20% in comparison with 1990 levels (30% if other developed countries join the effort). The European Union is preparing a legislative package that tackles these aspects. On the one hand, it will table a modification of the Emissions Trading Scheme (EU ETS), to be implemented after 2012. On the other hand, a directive for renewable energies (RE), with the details on how to split the 20% by country and by sector - biofuels, heating and cooling and electricity will be included. Complementarily, it will contain a number of provisions for the sectors not captured by the EU ETS.

Yet the two targets are not independent: one major way of curbing greenhouse gas emissions comes from replacing fossil fuel energy by renewable energy, whose environmental impact is less. Any strategy to achieve the 20% greenhouse gas target needs to take into account the role that renewable energies will have by then.

This paper discusses how best the EU ETS and the RE directives can be integrated, using wind as an example. Wind is the most dynamic renewable energy in Europe and in the world; it already covers 3% of electricity demand in the EU - up to 23% in Denmark and around 8% in Spain and Germany - (EWEA, 2007a) and is the second largest attractor of energy investments after natural gas (Platts, 2007).

Section 2 of this paper is devoted to reviewing the current state of the EU ETS, and the flaws of that scheme, which has failed to encourage the necessary investment in renewable energies.

Section 3 covers the topic of whether CO\textsubscript{2} emission reduction certificates could eventually constitute a sufficient reward for wind energy investments, and thus replace the payment schemes that, under different modalities (feed-in tariffs, green certificates, tax rebates or tenders) are now granted to wind-produced kWh in each Member State. The analysis is done in several steps: we first discuss the rationale behind the support given to wind and the other renewables that produce electricity (RES-e), and whether the CO\textsubscript{2} emission reduction certificates can capture its benefits. Second, we make a hypothetical calculation on the minimum CO\textsubscript{2} price that would keep the level of wind support constant in the different Member States.
Third, we introduce the effect of having highly volatile CO\textsubscript{2} prices, and their impact on the profitability of wind investments.

Section 4 deals with Clean Development Mechanism (CDM) and Joint Implementation (JI) project based schemes, and the role they have had in boosting wind investments in developing countries. This is accomplished through a review of the projects that have been registered until now by the United Nations and a series of structured in-depth interviews of the major wind energy investors in these areas.

Finally, some conclusions and recommendations on how best to use the future EU ETS to promote both CO\textsubscript{2} emission reductions and wind energy investments are put forward in section 5.

2. Current state of the ETS and proposed changes for the post 2012 period

2.1 Approval and performance of the EU ETS directive (2005-2007)

In order to tackle climate change and help EU Member States achieve compliance with their commitments under the Kyoto Protocol (reduction of 8\% of EU’s greenhouse gases during the period between 2008-2012), the European Union decided to set up an internal market enabling companies to trade CO\textsubscript{2} permits. Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 established the EU Emissions Trading Scheme. This scheme is linked to the Kyoto Protocol’s flexible mechanisms through Directive 2004/101/EC. On 1 January 2005 the EU Emissions Trading Scheme became a reality, and is being implemented in two periods: the first runs from 2005 to 2007 and the second from 2008 to 2012.

Since January 2005, some 12,000 installations across the EU-25 are capped in their emissions (Community Transaction Log, 2007) and the EU ETS has become the largest “cap and trade” programme worldwide: one billion tons of CO\textsubscript{2} equivalent worth €18.1 billion were traded in 2006 (Point Carbon, 2007).

Unfortunately, this market has failed to achieve some of its most important goals, notably encouraging investment in clean technologies and the use of CO\textsubscript{2} emissions reduction certificates as a market signal to regulate greenhouse gas (GHG) emissions. The main problems can be grouped as follows:

2.1.1. Political national influence and over-allocation of permits

Under the current system, a significant degree of freedom over the elaboration of the National Allocation Plans (NAPs) is retained by Member States (del Río González, 2006a; Kruger, Oates and Pizer, 2007).

Actual verified emissions in 2005 showed that allowances had exceeded emissions by about 80 million tons of CO\textsubscript{2}, equivalent to 4\% of the EU’s intended maximum level (Ellerman and Buchner, 2007). This happened because Government allocation had been based on projected future needs. At the same time, participants had a strong incentive to overestimate their needs (ENDS Europe Report, 2007).

The publication of those figures provoked the collapse of the CO\textsubscript{2} prices to less than €10/tCO\textsubscript{2} in Spring 2006. By the end of 2006 and into early 2007 the price of allowances fell below €1/tCO\textsubscript{2} (€0.15/tCO\textsubscript{2} in May 2007) (www.pointcarbon.com). Moreover, the over-allocation of permits has hampered any initiative of clean technology investment, as it is clear that most companies regulated by the EU ETS need not make any change to their current production processes to meet the target they have been assigned.

2.1.2. Counterproductive allocation methods: free allocation and windfall profits for conventional power generators

The Emissions Trading Directive stipulates that at least 95\% of issued allowances should be allocated for free for the period 2005-2007. For the next trading period, 2008-2012, this value is reduced to 90\%.

One controversial feature of the EU ETS has been the resulting impact of emissions trading in the power sector, through the increase of electricity prices. This happens because the power generation sector sets prices relative to marginal costs of production. These marginal costs include the opportunity costs of CO\textsubscript{2}...
allowances, even if allowances are granted for free. As a consequence, fossil fuel power producers receive a higher price for each kWh they produce, even if the costs for emitting CO\textsubscript{2} only apply to a minor part of their merchandise. This effect is known as windfall profit.

The ability of the power generation sector to profit from the EU ETS is attributed to the price inelastic nature of electricity demand, the low trade intensity and hence high ability to pass through CO\textsubscript{2} opportunity costs in electricity prices (Demailly et al., 2007). As illustrated in detail by the International Energy Agency (Reinaud, 2007), there is a strong correlation between CO\textsubscript{2} prices and electricity prices. However, national differences in electricity market structures and regulations means there is no universal answer to how the EU ETS has affected electricity prices. Pass-through of CO\textsubscript{2} prices into power prices varies across the different markets.

In the United Kingdom the impact of CO\textsubscript{2} price on the power price has been one of 100% pass-through (Point Carbon, 2007). In Germany and the Netherlands empirical and model findings show estimates of CO\textsubscript{2} cost pass-through rates varying between 60% and 100% for the wholesale power markets (Sijm et al., 2006a and Sijm, J., Neuhoff, K., Chen, Y., 2006b). In the same line, a Finnish study (Honkatukia et al. 2006) assessed the developments of the EU ETS during the first 16 months. Based on econometric calculations, the results indicate that approximately 75% to 95% of the price changes in the EU ETS are passed on to the Finnish Nord Pool day-ahead prices.

Furthermore, Sijm et al. 2006 shows that Europe’s power companies have made well over €1 billion profits from the EU ETS to date, and suggests that the sector will make net profits of tens of billions of euros during the second phase.

2.1.3. Limited scope of the EU ETS to certain gases and few economic sectors
Around 55% of the CO\textsubscript{2} emitted in the EU comes from sectors outside the EU ETS (EC, 2007a). In the same way, other more powerful greenhouse gases, such as nitrous oxide, sulphurhexafluoride and methane are excluded. The experience from the past years illustrates that it is precisely in some of the sectors that have been left outside— notably transport – where the highest GHG emission growth rates have occurred (Eurostat, 2007). The long-term success of the EU ETS requires their inclusion.

2.2 The way ahead: proposals for the post 2012 period

In view of the above-mentioned elements and as a preliminary step to design the third phase of the EU ETS (post 2012), the European Commission has embarked in a public consultation on how the new system should look like. The debate started in November 2006 with the publication of the Communication “Building a global carbon market – Report pursuant to Article 30 of Directive 2003/87/EC” (EC 2006c) and has involved numerous stakeholders: Member States through the European Council (Environment Council meetings of 20 February 2007 and 28 June 2007, Brussels European Council of 8-9 March 2007), the European Parliament through the new Temporary Committee on Climate Change and Environment Committee meetings, NGOs, industries and social actors.

At the end, and although final agreement still has to be reached on a number of issues, the main elements seem to be the following:

• Inclusion of the aviation sector (EC, 2006d);
• More consistent, harmonised and aligned application of monitoring, reporting and verification requirements (EC, 2007d);
• An improved, more transparent and centralized cap setting;
• Longer trading periods: from 2013 to 2020 (EC, 2007e);
• Replacement of grandfathering by benchmarking(EU-wide) and auctioning (EC, 2007e);
• Increased levels of auctioning (Council of the European Union, 2007b);
• Restricted limits to the use of CDM and JI credits.
2.3 Implications of the post 2012 EU ETS rules on the wind energy sector

Wind can make an important contribution to curbing CO\(_2\) emissions, as required by the EU ETS. The at least 80 GW of installed capacity that is expected by 2010 (EWEA, 2006; EER, 2007, BTM, 2007; EC, 2006a\(^1\)) will result in the decrease of 144.02 million of tons of CO\(_2\), equivalent to 36% of the overall EU reduction target by 2010. By 2020, 180 GW of onshore and offshore wind power could be installed in the European Union and this would entail a saving of around 370 million tons (EWEA, 2006). Note that there is a wide range of forecasts about what wind energy could supply in the future. To give an example, the scenarios for energy efficiency and renewables recently published by the European Commission (EC, 2006b) include the prediction that, by 2020, wind energy can supply 208.6 GW – high renewables case\(^2\). The figure we are using is thus not the highest that has been proposed, but what seems to us a mid approach, given the institutional framework and the conditions of the energy market in Europe.

But the impact is not uni-directional, as the wind energy sector will also be affected by the future EU ETS directive in a number of ways:

- The final decision on whether or not auctioning is applied will alter the incentives of the affected sectors to invest in cleaner processes, including wind, given the disappearance of windfall profits;
- Wind and the other renewable and energy efficient solutions could enjoy support from other financial sources if the fines and auctioning revenues were devoted to “clean investments”;
- The value of the CO\(_2\) certificate gained by wind energy investment could constitute an additional incentive to invest in this technology;
- The CDM and the JI options could act as catalysts for the development of wind in non-EU countries, thanks to the increased remuneration that they would receive in the form of credits.

While the first points have already been discussed, we now turn to the last two, which constitute a fundamental part of the current efforts to help renewable energies develop while at the same way ensuring the coherence of the overall legislative package.

3. EU ETS and the support mechanisms for wind energy

One interesting aspect is the discussion on whether the EU ETS market, if adequately implemented, would create enough incentives for wind energy to develop without the need of further financial support. At the moment, wind and the other renewable sources that produce electricity (RES-e) benefit from some type of rewarding in the form of a feed-in tariff, premium over the electricity price, green certificate or tax rebate (EC, 2007b).

While the directive gives Member States the freedom to decide which mechanism they wish to apply, the reality shows that most countries (19 out of 27) grant some sort of feed-in/ premium scheme – which regulates the price that wind energy and the other RES-e will receive per kWh, higher than the market prices –, while the others tend to use certificates – which regulate the amount of electricity coming from wind and the other RES-e that has to be produced or consumed every year. A comprehensive explanation of those mechanisms can be found in several research papers and EU-funded projects (RE-Xpansion, 2005; Optres, 2006; ISI and EEG, 2006).

A strong CO\(_2\) price could indeed become an additional incentive for the deployment of renewable energies, including wind. The question is whether this is enough to suppress any other form of support and whether the simplification really helps improve the coherence of the overall legislative package.

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\(^1\) Page 34. Table 1-14: 78.4 GW by 2010. As calculated by the Primes model.

\(^2\) Page 35. Table 1.3-4. As calculated by the Primes model.
3.1 Reasons behind the financial support granted to RES-e: the value of wind

In the first place, we should discuss what the rationale is behind the support mechanisms paid to wind and the other RES-e under the directive 77/2001/EC. While it is clear that these sources entail significant benefits in terms of fighting climate change, they also bring along other – no less important – positive spillover effects.

Wind energy significantly contributes to the security of supply of the European Union by reducing energy imports – presently 50% of the EU energy primary energy supply, up to 65% by 2020 (EC, 2007c). It also helps diversify the portfolio of technologies available for electricity generation, thus decreasing the overall cost and risk (Awerbuch, 2006). None of these aspects are captured by individual power companies and thus give birth to an externality, which the European Commission considers so important that it is one of the major reasons behind the adoption of the 20% RE target in January 2007. Even if wind did not entail any reduction in CO\textsubscript{2} emissions, it would still be worth considering for this reason alone.

Another aspect behind the support given to wind lies in its potential to promote growth and jobs. According to the EU MITRE initiative (EC, 2004), 368,000 new jobs will be created thanks to the deployment of wind energy between 2000 and 2020 (advanced scenario). While Governments do not systematically collect statistics on the renewable energy sector, some countries have started making the effort to quantify the direct jobs that can be attributed to wind. In Spain, there are 31,500 (AEE, 2006); in Germany 64,000 (The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2006) and 21,600 in Denmark (DWEA, 2006). The impact of wind energy on local communities is certainly positive, although some effort is still needed in its quantification in emerging countries. The experiences that have been recorded (e.g. the international comparison made by DTI, 2005) show beneficial effects in terms of diversification of the economic base, higher income to the local population through the rent received by the owners of the land where the turbines are located – often public land – and a general boost to the economy through the multiplier effect.

Wind energy saves CO\textsubscript{2} but also NO\textsubscript{x}, SO\textsubscript{2} and other more local pollutants. Its benefits can be felt upon human health, animal and vegetal species and even on buildings. The well-known ExternE study (EC, 1995; 2005b) has consistently looked at those. Although this is surely not the place to give a detailed explanation of their findings, we can at least note that such elements are not considered by the CO\textsubscript{2} EU ETS market.

Finally, it is widely recognised that RES-E competes on an unequal playing field market with thermal-based conventional electricity. Fossil-fuel sources receive much higher support than renewable energies (del Río González, 2006b). This support can be explicit (as it is the case of subsidies to the coal industry or to extensive nuclear research programmes) or implicit (funding of energy infrastructure, paid using government budgets; the use of the Structural Funds Interventions and Cohesion Funds, etc.). A rough estimate of energy subsidies in the EU-15 has been carried out by the European Environment Agency (EEA, 2004). EEA analysis (see also EEA, 2006) shows that the amount of subsidies received by renewables is less than 20% and that almost three quarters are oriented towards the support of fossil fuel alternatives.

In summary we can conclude that the reasons justifying the establishment of a support mechanism for wind and the other RES-e go far beyond their reduced CO\textsubscript{2} emission factor and that the EU ETS has not been designed to take them into account. If the level of CO\textsubscript{2} prices is high enough (as it will be worked out in the next sub-section), it could be enough to foster wind development, but still would not constitute an optimal approach from the economic and social point of view.

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Page 5 of the Communication “An Energy Policy for Europe”.
3.2 Modeling the CO$_2$ prices that could maintain the current level of wind support constant and risk analysis

Table 1 illustrates prices that each ton of CO$_2$ should achieve in the national markets to keep the level of support granted to wind energy constant (2006 figures). Where feed-in tariffs exist, we took the price that is granted to each kWh produced with wind. Where certificates are the chosen option, we used the most recent price of the certificates as a benchmark. In the other (few) cases, we picked the best indicator of support that was available. The electricity price is the weighted mean of the average spot prices during 2006 for the main EU markets: Nordpool, POLPX, EEX, IPEX, OMEL, Powernext, Belpex, APX power UK, APX power NL. The amount of CO$_2$ avoided by wind comes from the International Energy Agency Outlook Report 2006. We assume that the wind farm owner would sell the electricity at the spot price and receive a supplementary remuneration in the form of CO$_2$ credits for the GHG it avoids. These credits would then be sold in the appropriate market.

Table 1: Comparison between support system for wind and the CO$_2$ price that would be needed to keep remuneration level constant excluding compliance costs, risk and long term stability.

<table>
<thead>
<tr>
<th>Country</th>
<th>Wind incentive €/kWh in 2006</th>
<th>Spot price €/kWh in 2006</th>
<th>Difference support - electricity price €/kWh in 2006</th>
<th>CO$_2$ price €/ton needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>0.078</td>
<td>0.057</td>
<td>0.021</td>
<td>26.34</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.075</td>
<td>0.057</td>
<td>0.018</td>
<td>22.61</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0.087</td>
<td>0.057</td>
<td>0.030</td>
<td>37.16</td>
</tr>
<tr>
<td>Cyprus</td>
<td>0.070</td>
<td>0.057</td>
<td>0.013</td>
<td>16.02</td>
</tr>
<tr>
<td>Czech Rep</td>
<td>0.090</td>
<td>0.057</td>
<td>0.033</td>
<td>41.26</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.036</td>
<td>0.057</td>
<td>-0.021</td>
<td>-25.52</td>
</tr>
<tr>
<td>Estonia</td>
<td>0.077</td>
<td>0.057</td>
<td>0.020</td>
<td>24.78</td>
</tr>
<tr>
<td>Finland</td>
<td>0.007</td>
<td>0.057</td>
<td>-0.050</td>
<td>-62.08</td>
</tr>
<tr>
<td>France</td>
<td>0.084</td>
<td>0.057</td>
<td>0.027</td>
<td>33.30</td>
</tr>
<tr>
<td>Germany</td>
<td>0.090</td>
<td>0.057</td>
<td>0.033</td>
<td>40.64</td>
</tr>
<tr>
<td>Greece</td>
<td>0.074</td>
<td>0.057</td>
<td>0.017</td>
<td>21.24</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.096</td>
<td>0.057</td>
<td>0.039</td>
<td>48.22</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.058</td>
<td>0.057</td>
<td>0.001</td>
<td>0.85</td>
</tr>
<tr>
<td>Italy</td>
<td>0.185</td>
<td>0.057</td>
<td>0.128</td>
<td>159.40</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.025</td>
<td>0.057</td>
<td>-0.032</td>
<td>-39.57</td>
</tr>
<tr>
<td>Lithuania</td>
<td>0.063</td>
<td>0.057</td>
<td>0.006</td>
<td>7.69</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.025</td>
<td>0.057</td>
<td>-0.032</td>
<td>-39.57</td>
</tr>
<tr>
<td>Malta</td>
<td>n.a.</td>
<td>0.057</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.085</td>
<td>0.057</td>
<td>0.028</td>
<td>35.04</td>
</tr>
<tr>
<td>Poland</td>
<td>0.090</td>
<td>0.057</td>
<td>0.033</td>
<td>41.26</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.082</td>
<td>0.057</td>
<td>0.025</td>
<td>31.31</td>
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<tr>
<td>Romania</td>
<td>0.085</td>
<td>0.057</td>
<td>0.028</td>
<td>35.04</td>
</tr>
<tr>
<td>Slovakia</td>
<td>0.085</td>
<td>0.057</td>
<td>0.028</td>
<td>35.29</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.060</td>
<td>0.057</td>
<td>0.003</td>
<td>3.52</td>
</tr>
<tr>
<td>Spain</td>
<td>0.093</td>
<td>0.057</td>
<td>0.037</td>
<td>45.49</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.076</td>
<td>0.057</td>
<td>0.019</td>
<td>23.85</td>
</tr>
<tr>
<td>UK</td>
<td>0.077</td>
<td>0.057</td>
<td>0.020</td>
<td>24.47</td>
</tr>
</tbody>
</table>

Source: own elaboration.

As can be seen, the CO$_2$ prices that would guarantee current levels of support in the EU show considerable variation and are even negative in a few cases (Denmark, Finland, Latvia and Luxembourg). Where positive, they range from the €159.40/tCO$_2$ that would be necessary in Italy to only €0.85/tCO$_2$ in Ireland.
Several remarks need to be made: Table 1 reflects the CO$_2$ prices that would keep current support levels constant, not the CO$_2$ prices that would ensure the deployment of wind energy in Europe. Indeed, only some EU countries now have support systems that allow this technology to develop.

Figure 1 shows the new wind energy installations in Europe during 2006. Germany (29.43% market share); Spain (20.92%); France (10.68%); Portugal (9.15%); the United Kingdom (8.36%) and Italy (5.50%) were the market leaders. The remaining countries scored very poorly and a number of them (Cyprus, Estonia, Latvia, Luxembourg, Malta, Slovenia and Slovakia) did not install a single MW in that period.

As could be expected, there is a clear relationship between the level of support (hence, the CO$_2$ price that would replace it) and the capacity installed in each country. The CO$_2$ prices that are relevant for us are therefore those coming from market leaders, because they reveal a remuneration that is reasonable and sufficient for wind energy investors. In table 1, these are the €40.64/tCO$_2$ that would be needed in Germany; €45.49/tCO$_2$ in Spain; €33.30/tCO$_2$ in France; €31.30/tCO$_2$ in Portugal; €24.47/tCO$_2$ in the UK and €159.40/tCO$_2$ in Italy. Such values are already much more homogeneous and point to CO$_2$ prices of around €40/tCO$_2$ avoided by wind, except in the case of Italy, where it is substantially higher.

To explain this apparent divergence we turn to risk assessment.

3.3 Introducing risk into the analysis

Certainly, a second – crucial – factor that table 1 does not take into account is the level of risk faced by the wind developer at the time of making the investment. Wind energy investments are very capital intensive (no fuel cost, therefore most of the total investment cost is made at the time of setting up the plant) in comparison with other electricity generation techniques, therefore a safe flow of income becomes fundamental.

Four out of the six market leaders in 2006 had a support system of feed-in or premium prices, which secures the perception of income – fixed or within a narrow band – for a period of between 10 and 25
years, depending on the country and on the size of the project. In other words, the €40.64/tCO\textsubscript{2} in Germany would replace the current EEG law only if this price were guaranteed for 20 years (ISI and EEG, 2007). The same applies to Portugal (15 years), France (15 years for onshore and 20 years for offshore) and Spain (25 years). In the UK, a mixed system is applied: wind energy suppliers have to demonstrate the compliance with a quota obligation through tradable green certificates — the Renewables Obligation Certificates (ROCs). The quota obligation is set out to 2015 with a guarantee to remain at least at the same level until 2027. The support mechanism for renewables in Italy is the most similar to the CO\textsubscript{2} certificates market. This explains the large gap in the remuneration level between the two groups of Member States. The Italian example should also be considered as a good indicator of the CO\textsubscript{2} price that the wind energy sector would need if no other formula for securing the investment is provided.

The EU ETS CO\textsubscript{2} market has proved extremely volatile with prices moving from almost €30 to €9 in one month and to less than €1 in 10 months (www.pointcarbon.com) and there are no signs that the price can fluctuate less. The forecasted prices of CO\textsubscript{2} for the third period of the EU ETS are normally below the level of €40/tCO\textsubscript{2} and very far from the €149/tCO\textsubscript{2} that should be granted to Italian investors.

In addition, we have modeled the influence of future electricity prices in the viability of wind energy developments remunerated through the spot price plus the income they get from the sale of CO\textsubscript{2} certificates. We have used a low forecasted price of 4.5 €cent/kWh and a high forecast of 7 €cent/kWh for the year 2010. The amount of CO\textsubscript{2} saved by a kWh produced with wind is assumed to be less than in 2006 (again, figures come from the International Energy Agency Outlook Report 2006) so that they reflect the higher share that renewable energies should have in the electricity mix by then.

The results shown in table 2 prove that the future trend of electricity prices will play a crucial role in the profitability of wind energy investments should this form of remuneration be applied. Electricity prices are mainly governed by fluctuations in the fuel and gas markets and can be considered as exogenous for the wind farm developer.

\textit{Table 2: CO\textsubscript{2} prices needed in 2010 to keep current levels of support constant in the EU, excluding compliance costs, risk and long term stability, under different electricity price scenarios.}

<table>
<thead>
<tr>
<th>Country</th>
<th>CO\textsubscript{2} price €/ton needed - electricity price of 4.5€cent/kWh</th>
<th>CO\textsubscript{2} price €/ton needed - electricity price of 7 €cent/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>41.13</td>
<td>9.97</td>
</tr>
<tr>
<td>Belgium</td>
<td>37.39</td>
<td>6.23</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>51.97</td>
<td>20.81</td>
</tr>
<tr>
<td>Cyprus</td>
<td>30.78</td>
<td>-0.37</td>
</tr>
<tr>
<td>Czech Rep</td>
<td>56.08</td>
<td>24.92</td>
</tr>
<tr>
<td>Denmark</td>
<td>-10.84</td>
<td>-42.00</td>
</tr>
<tr>
<td>Estonia</td>
<td>39.57</td>
<td>8.41</td>
</tr>
<tr>
<td>Finland</td>
<td>-47.48</td>
<td>-78.64</td>
</tr>
<tr>
<td>France</td>
<td>48.11</td>
<td>16.95</td>
</tr>
<tr>
<td>Germany</td>
<td>55.46</td>
<td>24.30</td>
</tr>
<tr>
<td>Greece</td>
<td>36.02</td>
<td>4.86</td>
</tr>
<tr>
<td>Hungary</td>
<td>63.06</td>
<td>31.90</td>
</tr>
<tr>
<td>Ireland</td>
<td>15.58</td>
<td>-15.58</td>
</tr>
<tr>
<td>Italy</td>
<td>174.47</td>
<td>143.32</td>
</tr>
<tr>
<td>Latvia</td>
<td>-24.92</td>
<td>-56.08</td>
</tr>
<tr>
<td>Lithuania</td>
<td>22.43</td>
<td>-8.72</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>-24.92</td>
<td>-56.08</td>
</tr>
<tr>
<td>Malta</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Netherlands</td>
<td>49.85</td>
<td>18.69</td>
</tr>
<tr>
<td>Poland</td>
<td>56.08</td>
<td>24.92</td>
</tr>
<tr>
<td>Portugal</td>
<td>46.11</td>
<td>14.95</td>
</tr>
</tbody>
</table>
In the high electricity price scenario, the price of a ton of CO\(_2\) in Germany should be of around €24; €143 in Italy. At the lowest end, €55.5 and €174.5 would be required. Again, this is a rough estimate, which does not take into account the risks of a volatile CO\(_2\) certificate market.

To end this discussion, we sought to replace the average amount of CO\(_2\) saved by a kWh of wind as it was calculated by the IEA by the average emission factor that was reported by Member States when preparing their National Action Plans of the EU ETS. The reason for doing this is that in the calculation of CDMs and JI credits (see next section) the baseline scenario is the average emission factor of a kWh in the recipient country. A similar approach could be used in Europe.

We did not find data for all the countries (Bulgaria, Czech Republic, Hungary, Italy, Portugal, Slovenia, among others) and in some countries the series were incomplete (Denmark, Estonia, France, Luxembourg, Spain and the United Kingdom). Moreover, the NAPs only report on power plants of over 20 MW, which means that the emission factors found (total electricity produced in kWh/CO\(_2\) emissions covered by the EU ETS) underestimate the total emissions and the emission factor. In reality, the data is too patchy to allow for a real comparison.

Where the exercise could be conducted results are not homogeneous. In certain countries, the replacement of an EU-wide measure of CO\(_2\) avoided by the one that comes from the NAP implies a lower saving of CO\(_2\) per kWh generated with wind. This is the case of Austria, Belgium or Finland, where hydroelectricity and/or nuclear constitute the lion’s share of electricity generation\(^4\). In other countries, notably Eastern European, which heavily rely on coal, the savings of wind are truly substantial and appear underestimated by the EU average. Thus, wind energy investments in those countries would entail a higher number of CO\(_2\) credits. This would naturally entail a higher profitability of investments carried out there, if the remuneration would solely come from the CO\(_2\) markets. Still, let’s remember that the most important element in a wind energy investment is the resource; that is the existence of sufficient wind. CO\(_2\) markets do not take this element into account.

4. **The role of CDM and JI for the deployment of wind**

This section is devoted to debating to what extent have the CDM and the JI mechanisms been capable of fostering wind energy investments in third countries and the impact of CDM and JI credits on the carbon price and on clean technology investments in the EU. The analysis is based upon the data published by the United Nations Framework Convention on Climate Change (UNFCC, 2007) and UNEP-Risoe (2007), complemented with interviews to a representative sample of wind energy developers that have carried out projects in eligible areas.

The Linking Directive (Directive 2004/101/EC) offers EU Member States the possibility to bond the EU ETS with the Kyoto Protocol’s Joint Implementation and Clean Development Mechanism. Member States are allowed to use credits from carbon reduction projects – certified emission reductions (CERs) and emission reduction units (ERUs) – to offset national GHG emissions as they appear in their national allocation plans. The system is expected to offer EU countries emission cuts which are cheaper in

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\(^4\) However, wind energy normally does not replace base load technologies, such as nuclear or hydro. It mainly replaces coal, gas and oil, which were precisely the sources used for comparison when applying the IEA figures.
developing countries than at home – since global warming is a worldwide problem and what matters is the total level of emissions – and to foster technology transfers.

4.1 The role of CDM and JI for the deployment of wind energy projects in third countries

According to UNEP-Risoe, 257 wind projects – with a capacity of 10,176.4 MW – have applied for the CDM scheme. This represents 11% of the applications received, ranked third after hydro (503 applications) and biomass (436). Of those, only a fraction have been accepted and registered. So as to avoid a biased judgment based on projects that have been rejected or which remain uncertain our analysis concentrates on the former.

The table below contains some key statistics of the 101 wind projects registered by the UNEP so far. In total, they add an installed capacity of 4,549 MW, capable of saving an annual amount of 8,719.00 ktCO₂. By 2012, these wind farms will have saved 56,346.00 ktCO₂ and by 2030 an amount 145,191.00 ktCO₂. The immense majority of the credits allowed has been purchased by Europeans and thus is eligible for the EU ETS. Japan is the only non-EU buyer participating in this market.

Table 3: Registered CDM projects.

<table>
<thead>
<tr>
<th>Title</th>
<th>Nº of projects</th>
<th>ktCO₂/yr 2012</th>
<th>2012 ktCO₂</th>
<th>2030 ktCO₂</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1</td>
<td>27</td>
<td>302</td>
<td>565</td>
<td>10.6</td>
</tr>
<tr>
<td>Brazil</td>
<td>4</td>
<td>170</td>
<td>1040</td>
<td>3560</td>
<td>165.6</td>
</tr>
<tr>
<td>China</td>
<td>41</td>
<td>4327</td>
<td>26361</td>
<td>89825</td>
<td>1995.1</td>
</tr>
<tr>
<td>Colombia</td>
<td>1</td>
<td>18</td>
<td>161</td>
<td>379</td>
<td>19.5</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>1</td>
<td>13</td>
<td>126</td>
<td>126</td>
<td>19.8</td>
</tr>
<tr>
<td>Cyprus</td>
<td>2</td>
<td>73</td>
<td>355</td>
<td>1524</td>
<td>46.5</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1</td>
<td>124</td>
<td>299</td>
<td>1239</td>
<td>64.6</td>
</tr>
<tr>
<td>Egypt</td>
<td>1</td>
<td>249</td>
<td>1305</td>
<td>5221</td>
<td>120.0</td>
</tr>
<tr>
<td>India</td>
<td>38</td>
<td>1784</td>
<td>16288</td>
<td>19246</td>
<td>1,138.2</td>
</tr>
<tr>
<td>Israel</td>
<td>1</td>
<td>39</td>
<td>208</td>
<td>820</td>
<td>11.5</td>
</tr>
<tr>
<td>Jamaica</td>
<td>1</td>
<td>53</td>
<td>456</td>
<td>525</td>
<td>20.7</td>
</tr>
<tr>
<td>Mexico</td>
<td>4</td>
<td>1393</td>
<td>6549</td>
<td>16051</td>
<td>696.3</td>
</tr>
<tr>
<td>Morocco</td>
<td>2</td>
<td>185</td>
<td>1144</td>
<td>2162</td>
<td>70.2</td>
</tr>
<tr>
<td>Philippines</td>
<td>1</td>
<td>57</td>
<td>436</td>
<td>1193</td>
<td>33.0</td>
</tr>
<tr>
<td>South Korea</td>
<td>2</td>
<td>209</td>
<td>1317</td>
<td>2755</td>
<td>137.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>101</td>
<td>8,719</td>
<td>56,346</td>
<td>145,191</td>
<td>4,549.14</td>
</tr>
</tbody>
</table>


The comparison between MW registered under the CDM scheme and the global installed capacity is not straightforward, because some of the projects are still under construction and therefore do not appear in the statistics. This is the case of Mexico which, at the end of 2006 had a cumulative installed capacity of 88 MW and projects registered for 696.3 MW. Looking at the original UNEP table we can observe that most of the CDM credits have been awarded during the course of 2007, and thus reveal the future installed capacity in that country.

Still, and trying to make a rough estimate of the size of the CDM mechanism in comparison with the global market, we observe that the registered capacity constitutes little more than 6% of the capacity installed worldwide (GWEC, 2007) but 40% of the installations in countries that can benefit from CDM (thus excluding the EU, Canada, US, Australia, etc.). Considering that CDM are approved only recently, we can assert that a good proportion of the projects that are or will be developed in those areas are looking for the awarding of credits.

Figures as of 18th of July 2007.
The situation of Joint Implementation projects (JI) is very different. Until now, 25 wind projects have applied for this mechanism\(^6\) (14% of the total), but none has been registered. JI credits can only be issued for a crediting period starting in the beginning of 2008 and thus companies are still in a projects submission phase. A thorough analysis on the effectiveness of this tool to promote wind energy investments will have to be made in the future.

Returning to the CDM table, a very interesting point is to see the connection between registered projects and the energy policy applied in those countries. The figures prove the concentration of CDM projects in a couple of countries: China (41%) and India (38%). This choice is not coincidental. Both countries are ranked eight and third respectively in the Renewable Energy Country Attractiveness Indicator\(^7\) (Ernst & Young, 2007), which takes into account wind potential as well as the political and legal framework. China’s potential is huge and the Renewable Energy Law of the People’s Republic of China from 2005 provides attractive conditions for the establishment of wind farms. The situation is India is not very different. The country has good potential and solid fiscal policies in place, with utilities obliged to source a certain percentage of their supply from renewables. Today, India is already the fourth largest wind producer in the world.

The other two countries with a significant number of registered projects (Brazil and Mexico, 4 projects each) also have positive legislative frameworks and incipient markets (GWEC, 2007). Brazil counts on the PROINFA scheme and several hundred MW will enter into operation in 2007 and 2008. In Mexico, the excellent resource and the Renewable Utilisation Programme plus the creation of a trust to support RE projects are giving good results (AMDEE, 2007). In reality, the countries where CDM projects have been registered are the countries that appear as the most attractive for wind investments in the several geographical areas.

The survey that we have carried out among wind energy developers\(^8\) confirms the strong correlation between the political/legal framework of the CDM projects’ host countries and the development of these projects. All our interviewees identify the favourable policy framework as the main driver behind the deployment of wind energy projects in these countries. The possibility of using CDM mechanisms, access to the grid and the local stakeholders appear as secondary decision factors. Furthermore, an analysis of the CDM and JI credit prices shows that they are not sufficient to make renewable electricity projects attractive for investors (see, for instance del Río González, 2005). Reported CER prices in 2006 have varied between €3.5/ton and €20/ton. ERU prices in 2006 were between €4.5 and €12.5 (Point Carbon, 2007). These figures should be compared with the ones that we have found in section 3.2 of this article.

Other barriers that hinder wind energy projects in these areas, as identified in our study, refer to the volatility of the market, the methodology applied for the calculation of the CO\(_2\) credits and the administrative procedures.

In terms of market volatility, CER prices are uncertain (see above) and the internal return rate of the project varies significantly from country to country. With the same level of investment, project developers can obtain a different number of credits and profit depending on the country where they carry out the investment. This is due to the relation between CER price and the baseline scenario used to compare the emissions of wind projects with the average emissions of the electricity sector. For example, countries where the electricity mix mainly relies on hydro – i.e. Brazil, Colombia, Costa Rica – will provide fewer credits to the wind energy investor than countries using coal and lignite, regardless of the contribution that the new installation makes to the electricity needs of the country, and the evidence that a wind farm

\(^6\) 22 projects in Eastern Europe.

\(^7\) Short term wind indicator, which mainly takes into account wind potential available and the political framework. This indicator is one of the most prestigious for the analysis of RE markets.

\(^8\) The analysis of the UNFCCC wind projects pages helped us identify the 10 wind energy developers that have CDM projects at registration or verification phase. We sent a similar questionnaire to all of them and have received 7 responses (70%). The written responses have been complemented by in-depth interviews.
replaces coal, gas and oil (intermediate and peak demand technologies) and not hydro or renewables. For a CER price of €20/ton, a wind farm in India can get 2 ¢cents/kWh and only 1 ¢cent/kWh in Colombia.

The methodology applied for the calculation of the CO$_2$ reduction puts wind energy projects at a disadvantage in comparison with other options, as the system awards more credits to projects that reduce CH$_4$ (methane), N$_2$O (nitrous oxide), HFCs (hydrofluorocarbons), PFCs (perfluorocarbons) and SF$_6$ (sulfur hexafluoride) whose global warming potential is greater. In this way, renewable energy projects, which account for around 66% of the CDM market, will only generate 26% of the credits between now and 2012. Projects that reduce HFC-23 and SF6 constitute 3% of the market projects, but will get 35% of the credits. Yet, the contribution that the different initiatives make to the sustainable development of the recipient countries – in terms of supplying a basic commodity like electricity, of creating a sound industrial base and of effectively transferring technological expertise – may not be the same. Most of the respondents suggested the introduction of a “correction factor” similar to the global warming potential should be used for projects that contribute to the effective development of the least-favoured countries.

Administrative procedures have become a major obstacle to CDM/JI projects. The registration and validation is time consuming, bureaucratic and costly: it can take 1 to 2 years from the project identification to the project registration and any minor change in the initial design –even if is not provoked by the developer (i.e. delays in the creation of the public infrastructure that is needed prior to the erection of the turbines) will imply the cancellation of the process and the need to re-submit all the documents again. The developer has to prove the “additionality” of the investment, and demonstrate that his/her project is not common practice in the recipient country and that it would not take place if the CDM/JI credits were not awarded. The methodology for proving this additionality is fairly random and detrimental to the development aspirations of beneficiary countries which, in contrast with developed Member States, do not normally count on other support mechanism for RES technologies.

Finally, our respondents highlighted the negative impact that the uncertainty of the Kyoto project-based mechanisms after 2012 exerts in terms of project financing. Since there is not any formal commitment that ensures the continuation of these mechanisms after that year, the financial institutions to which they ask for loans, only take into account the credits awarded until 2012.

4.2 The role of CDM and JI for the deployment of wind energy projects in Europe

As shown in the previous section, CDM and JI do not constitute at present a tool capable of diverting wind energy investments from Europe to developing countries, since the income that can be raised through them is low and CDM/ JI do not, per se guarantee the stable legislative framework that these projects require. We can therefore conclude that the direct impact of CDM/JI in the EU wind energy market is limited, and will remain so unless major modifications in the design and in the price of the CERs/ERUs occur.

However, the low price of CERs and ERUs on the EU ETS market can play an indirect negative role on wind energy – and other technologies – since their inflow to the EU ETS market further reduces the allowance prices in Europe and with them the little incentive that remains to invest in-house. An industry obliged to cut its emissions would prefer to import cheap JI or CDM credits instead of buying EU ETS credits or adapting its production process.

This is probably the reason behind the Commission’s proposal for the second trading period, to limit the use of external credits to between 10% and 20% of an installations’ total allocation (http://ec.europa.eu/environment/climat/2nd_phase_ep.htm). However, some studies consider that the access to the Kyoto mechanisms in the second EU ETS phase could still be significant (WWF-UK, 2007; Carbon Trust, 2007; Openeurope, 2007). According to WWF, between 88% and 100% of the emissions reduction required in France, Germany, Ireland, Netherlands, Poland, Spain and the United Kingdom could be met through a combination of emission permits awarded through “grandfathering” and through CERs and ERUs purchases in the international markets.

A final element around the use of the JI mechanism in the EU ETS and its impacts in wind energy investments is the danger of double counting. That is to say: the same emission reduction measure
generates ERUs (JI credits) and EUAs (EU ETS credits) at the same time. Two main cases of double counting can be distinguished: when projects within installations covered by the EU ETS are put forward as JI projects; and when projects linked with installations covered by the EU ETS create ERUs (UNIDO, 2003).

To avoid that one wind energy project can count as JI and an EU ETS project at the same time, more concrete rules and a tighter control should be applied.

5. Conclusions

The EU ETS market can constitute a valuable tool to reduce CO₂ emissions and at the same time encourage wind energy investments, provided that a number of flaws in its current designed are solved. These are the political national influence and over-allocation of permits; the adoption of full auctioning and the inclusion of other pollutant sectors and gases.

However, and since the EU ETS is solely concerned with cutting GHG emissions and does not comprehend other benefits of wind energy, like security of supply and employment creation, it does not represent an optimal tool to remunerate the external benefits of this sector. Generally speaking, climate policy is unlikely to provide sufficient incentives to promote wind power, and so other policies to internalize the societal benefits that accrue from deploying this technology should be used.

If CO₂ prices were the only payment scheme available for wind-produced electricity and assuming the maintenance of current support levels, two scenarios can be foreseen.

- In markets with feed-in tariffs, a minimum price of €40/tCO₂ (excluding transaction costs) should be attained. But feed-in tariffs guarantee the perception of the income during a period of between 10 and 25 years; this is not the case of CO₂ certificates, which are highly volatile and uncertain.
- In markets with green certificates, more comparable to the EU ETS, the minimum price should be of around €160/ton.

These figures are far from current and forecasted levels. The price of CO₂ certificates has never reached €30/tCO₂. In May 2007, it fell to €0.15/tCO₂. Future prices are difficult to predict, but specialists place them in the range of €20 to 30/tCO₂. Under these conditions, wind cannot rely on the EU ETS as a payment scheme. The future development of electricity prices and the selection of different baseline scenarios for calculating the avoided CO₂ emissions would have an impact on the certificate price but do not modify our central conclusions.

CDM and JI project-based schemes play a role in the development of wind energy projects in third countries, but they do not constitute the decisive element for a company that is considering investing there. It is the local institutional framework and the long term stability of the CO₂ markets which matters the most. Their impact on wind energy investments would increase if certain administrative and methodological problems were solved, like the shortening of the procedures and the review of the additionality clause.

CDM and JI are not capable of diverting wind energy investments from Europe to developing countries unless major modifications in the design and in the price of the CERs/ERUs occur. However, the low price of CERs and ERUs on the EU ETS market can play an indirect negative role on wind energy – and on other technologies – since their inflow can lead to a collapse of the EU ETS market and hinder any efforts to achieve domestic emission cuts and promote renewable energy investments in Europe.

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9 Industrial installations above the limits defined in the directive, power and heating plants with less than 20MW.
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