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Is the ETS still the best option?

Why opting for a carbon tax

by Stefano Clò & Emanuele Vendramin

Executive Summary

This paper assesses how effective the EU ETS has been so far in promoting emissions reduction and achieving the Kyoto emissions reduction targets. The analysis highlights the inefficiencies and market distortions that have characterised the ETS. The second part of the paper explains why most of the ETS related inefficiencies would be avoided by opting for a carbon tax and it assesses the further reduction of emissions that would have been promoted if a carbon tax were in place instead of the ETS.

ETS and emissions reduction The comparison between the carbon price and the theoretical coal-to-gas fuel switch carbon price reveals that during the period 2005-2011 the ETS promoted emissions reduction via fuel switching for almost one and a half years, corresponding to 193 Mton avoided carbon emissions in the ETS electricity sector. The ETS failed to give long-term and stable incentives to abate emissions.

ETS and cost imposition During the first trading period 2005-2007 the over-allocation of non-bankable allowances caused a collapse of the carbon price toward zero. This did not impede the ETS sectors from earning more than EU2 billion from the ETS. During the second phase, despite over-allocation leading to an aggregated surplus of 173 million allowances in 2009-2010, the ETS was split between buyers and sellers. Electricity sectors accumulated a deficit of 216 million allowances – and paid EU2.980 million to buy allowances – while the manufacturing industry held a surplus of 319 million allowances. This is a private asset that firms received for free and they can sell at the market price, generating revenues potentially equal to EU5.338 million. The ETS had an anti-cyclical effect, playing an insurance role against recession and credit crunch.

ETS and internal harmonization Despite being subjected to the same European regulation, national firms and sectors faced different reduction efforts depending on the country they are located. Indeed, Member States did not apply European climate policy uniformly, some of them being more protectionist than others. As a consequence, only some of the ETS sectors had to reduce their emissions while others, receiving more permits than they needed, could increase their emissions at no cost or gain money by selling their surplus of allowances. The lack of a level playing field has distorted competition, creating undesirable economic consequences at the expense of effective EU common market integration.

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ETS and Kyoto Data on the emissions reduction burdens imposed on the ETS sectors reveal that Member States did not sufficiently rely on the ETS to comply with their national Kyoto targets. The analysis clearly reveals widespread protectionist behavior: Member States preferred to protect national industries by setting a soft ETS cap rather than imposing effective emissions reduction according to their abatement opportunities. The ETS is not enough, and the Kyoto target will be achieved only if non trading sectors abate emissions more proportionally than their emissions share.

ETS and non-ETS Protectionism in favor of the ETS sectors had significant redistributive consequences since a higher ETS cap reduces the amount of emissions the ETS sectors have to abate, lowering the cost for the ETS, while increasing both the reduction target imposed on the non-ETS sectors and their compliance costs. By imposing soft ETS caps at a national level, Member States not only failed to implement the ETS efficiently, but they also indirectly subsidized private sectors with public funding, as governments are going to pay directly for the emissions the non-ETS sectors will not manage to reduce.

The ETS was expected to facilitate the achievement of EU emissions reduction targets at minimum compliance cost. To the contrary, both in the first trading period and in 2009 and 2010 the ETS sectors could profit from the climate regulation, while imposing a more proportional cost on the non-ETS sectors.

ETS: an uncertain future An high and stable carbon price is required to foster investments in low carbon technologies, which otherwise would fail to penetrate the market. In practice, the ETS has been characterized by a very high carbon price volatility - influenced by both market and regulatory uncertainties – and it has experienced several unexpected price reductions, allowing ETS installations to comply with the ETS without having to invest in low-carbon technologies. In spite of some improvements, the picture is not likely to change drastically during the next trading period. Also, during the third trading period 2013-2020 the ETS may fail to support low carbon technologies, as the carbon price is expected to be too low and unstable to make low carbon investments convenient and profitable.

ETS and ex-post interventions The European Commission has stressed on several occasions the importance of supporting the carbon price at a high and stable level in order to increase the competitiveness of low carbon technologies and foster their diffusion. Nevertheless, having already opted for a cap and trade scheme, the Commission is willing to reach this carbon price stability goal by adjusting the ETS cap through ex-post interventions. However, trying to pursue the price stability goal through quantity adjustments increases regulatory and administrative costs. It requires a deep and continuous policy intervention into the ETS, damaging its credibility as a market-based instrument.

Carbon tax and price stability Market operators welcome carbon price stability. Achieving this goal within the ETS (which is a quantity instrument) is very complicated and costly, thus inefficient. The same goal could be achieved at a lower administrative cost, and without any intrusive public intervention into the market, by opting for a price mechanism. A carbon tax appears the best option.

Carbon tax and fiscal revenues A carbon tax is a non-distortionary instrument that can facilitate the simultaneous achievement of different goals. It grants price stability, fostering the adoption of low carbon technologies and reducing the gap from the 2020 energy and climate targets. In the short run, given the actual debt crisis contingency, a carbon tax can reduce the deficit and public debt in those countries facing financial instability. In the long-run, distortions would be minimized through revenue neutrality: carbon tax fiscal revenues should be employed to reduce other distortionary taxes (i.e. labour taxes); this would reduce deadweight loss and promote economic growth. In this respect, cap and trade where only some of the allowances are auctioned is a second-best option since it would not create the same public revenues.

Carbon tax and harmonization By imposing an equal tax among ETS and non-ETS sectors, and among industrial and electricity sectors, a carbon tax could create a higher harmonization among economic sectors, reducing the distortions that have been in place with the ETS. If all the sectors had to pay a uniform price proportional to the amount of emissions they produce, higher harmonization would be granted, the resulting environmental policy would be more credible and effective, market distortions would be reduced. All this could be reached at a lower administrative cost by opting for an easier market-based instrument.

Carbon tax and emissions reduction If a carbon tax were in place instead of the ETS, we would have observed a higher emissions reduction via fuel switching. In particular, during the whole period 2005-2010 a carbon tax would have favored a further reduction of emissions in the ETS electricity sector from 7 Mton/year with a EU15ton carbon tax to 65 Mton/year with a EU30ton carbon tax.

1. Introduction

14 years have passed since the Kyoto Protocol was adopted on 11 December 1997. The end of 2012, the Kyoto commitment period chosen by the Parties to achieve the -5.2% emissions reduction target, seemed so far away at the time. Today, it is terrifically close. In the meantime, while the US Senate voted unanimously against ratifying the Protocol, the European Union (EU) took a different route. Against the opportunity of becoming the world leader in fighting climate change, **the EU priced the industrial and energy sectors' carbon emissions by creating the widest multi-national, emissions trading financial market in the world: the so-called European Emissions Trading Scheme (EU ETS)**; it also decided to move beyond Kyoto by approving the European Climate Package in 2008, which imposes a 20% emissions cut by 2020. Unfortunately, this was revealed to be a unilateral choice, as both the following Copenhagen and Cancun international negotiations failed to achieve a post-Kyoto binding agreement to further reduce worldwide emissions. As the Kyoto deadline draws ever closer and new challenges approach, it is time to look back and ahead. With this paper we try to answer the following questions: how far are we from the Kyoto target? How much have European states relied on the ETS to comply with their climate commitments? Can we still refer to the ETS as an effective market-based instrument that should have minimized the costs of abating emissions? Is the ETS still the best option or should we opt for easier and more effective instruments that would allow us to achieve the future targets at a lower cost?

This paper first assesses the effectiveness of the EU ETS in promoting emissions reduction and achieving Kyoto emissions reduction targets. The analysis highlights that the ETS caused many inefficiencies and market distortions. The second part of the paper explains why most of the ETS related inefficiencies would be avoided by opting for a carbon tax and it assesses the further emissions reductions that would have been promoted if a carbon tax were in place instead of the ETS.

2. The functioning of the ETS

The ETS is classified as a "cap and trade" market-based instrument: the regulator fixes ex-ante a limit to the amount of emissions that the regulated agents can produce (the ETS cap) and then it allocates a corresponding amount of allowances among the regulated agents according to a pre-defined allocation rule. Firms need an allowance for any ton of emission they produce and allowances can be freely traded within the ETS. Thus, if an agent produces more emissions than the amount of allowances it owns, it can comply with the regulation either by acquiring the amount of allowances required to cover its emissions gap at the market price or by reducing emissions internally.

The ETS can be defined as a quantity-based mechanism because the quantity of emissions that can be produced is fixed and known while the carbon price is not: it varies daily to balance the aggregate supply and demand of allowances, which depend, among other factors, on the uncertain, and often unpredictable, trends in energy markets. This is a crucial difference from price-base mechanisms, like a carbon tax, where the price for emitting is fixed while the quantity of emissions is not. As far as they pay, polluters can emit, thus the overall level of emissions that will be produced for a given tax is unknown.

3. Evaluating the ETS performance

There is no doubt the ETS represents a milestone within European and international climate policy. For the first time in Europe carbon emissions have been priced, and this represents the first essential step for reducing emissions and moving toward a low-carbon economy. Still, we must ask whether the ETS has so far been the promised widely acclaimed market-based economic instrument able to promote cost-effective emissions abatement, or rather a financial market where the best trained brokers could earn huge rewards without any significant environmental effects. According to the World Bank the ETS represents more than 80% of the global carbon market and, since it was launched in 2005, it has experienced a terrific expansion. Traded volume has more than doubled every year until 2008 and, in spite of the world financial crisis, it increased even in 2009. After five consecutive years of robust growth, in 2010 the market value of emissions permits traded within the ETS reached $120 billion.

3.1 First phase: Just a learning period

It is widely acknowledged that during the first trading period 2005-2007 the over-allocation of non-bankable[1] allowances caused a collapse of the carbon price toward zero. This did not imped the EU-25 ETS sectors[2] from earning more than EU2 billion, thanks to the huge amount of allowances they received for free. After all, "it was just a learning period", it has been argued; registries, monitoring and certification systems had to be launched, and ETS installations had to become confident with the system (for details see Appendix I).

3.2 Second phase: damned crisis

The beginning of the second phase looked sparkling. European GDP was growing, ETS emissions were expected to increase, as was the carbon price. A lower cap,[3] increasing emissions and bullish expectations brought the carbon price very close to EU30 ton on June 2008. But not for long. The financial crisis led to a major crisis across the European economy. Industrial production collapsed, primary energy consumption decreased even more,[4] lowering ETS emissions: -3% in 2008, -11,6% in 2009.[5] A substantial surplus of allowances flooded the market and in a few months the carbon price lost almost 70% of its value (-40% from 2008 to 2009). Nevertheless it did not collapse to zero as in the previous phase for two main reasons: banking and room for bargaining.

1 Initially allowances could not be banked and transferred from the first to the second trading period 2008-2012. Firms will have the option to transfer surplus allowances from the second to the third trading period 2013-2020.

2 Romania and Bulgaria have not been counted because in 2005 they were not included in the ETS.

3 To ensure scarcity of allowances, the European Commission previously cut the generous amount of allowances Member States wanted to allocate to the ETS sectors by 10%.

4 Demand for fossil fuels decreased and energy intensity followed. Efficient new plants were not introduced, only the most inefficient shut down.

5 Emissions did not grow again until 2010 (+2,8%).

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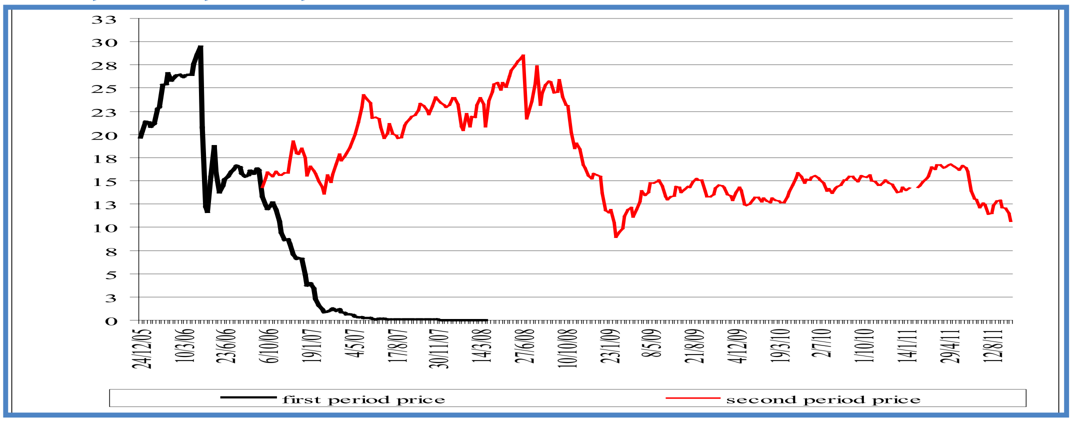
FIGURE 1

Carbon prices – spot EUA prices



Source: Bluenext, Pointcarbon

Banking: the value of undelivered allowances will not expire with the end of the second phase. They can be banked and transferred to the following period, when prices are expected to increase because of further reduction of the ETS cap and the recovery of the European economy. Because of this, demand for allowances has been sustained by power companies' hedging activities[6] and the ETS maintained an over-supply of allowances, meaning the carbon price did not fall toward zero.

Room for bargaining: despite over-allocation leading to an aggregated surplus of 173 million allowances in 2009-2010, the ETS was split between buyers and sellers. Electricity sectors accumulated a deficit of 216 million allowances – and paid EU2.980 million to buy allowances – while the manufacturing industry held a surplus of 319 million allowances. There are private assets that firms received for free and can sell at the market price, generating revenues of 5.338 million Euro (for more details see Appendix II). Most of this surplus was sold on: installations could increase financial liquidity and reduce budget constraints. The ETS had an anti -cyclical effect, playing an insurance role against recession and credit crunch. For participating firms, the financial fringe benefits of the ETS overcame its environmental purpose. [Figure 2]]

Not all the ETS players managed to benefit from the ETS, because of the significant transaction costs they have to pay (see Appendix III).

4. Is the ETS enough to comply with the Kyoto Protocol?

The ETS covers the emissions produced by more than 11,000 European installations belonging to the energy and manufacturing sectors. By combining the data on emissions produced by the national ETS sectors with national emissions data, during the period 2005-2009[7] we can estimate **the ETS emissions share**: the percentage of national emissions covered by the ETS (see Appendix IV). [Figure 3]

Since the ETS covers 40% of European greenhouse gas emissions,[8] complying with the ETS does not imply compliance with the Kyoto Protocol. Thus it will be useful to esti-

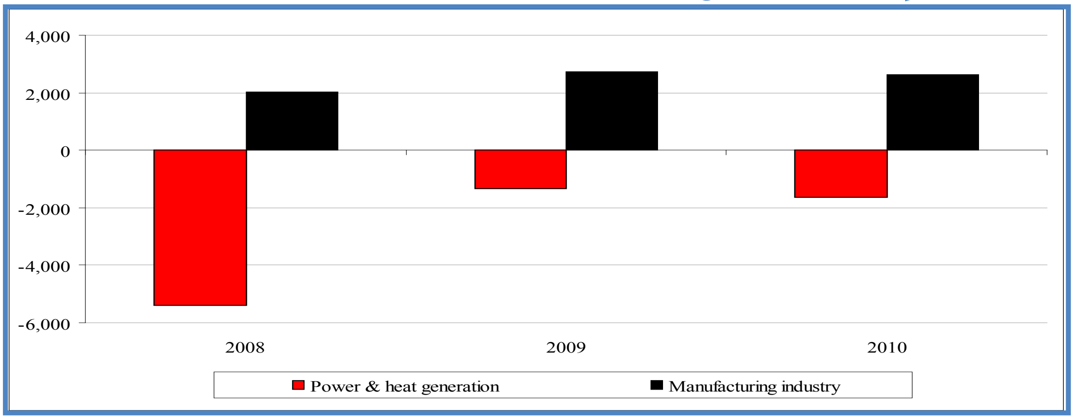
6 The power sector tends to sell electricity up to three years in advance. When stipulating these forward contracts, power companies find convenient to buy the amount of fuels and emission allowances required to cover their production in advance (hedging)

7 This is the only period for which both datasets are available

8 This percentage varies across countries (19% in Luxemburg and 67% in Malta)

FIGURE 2

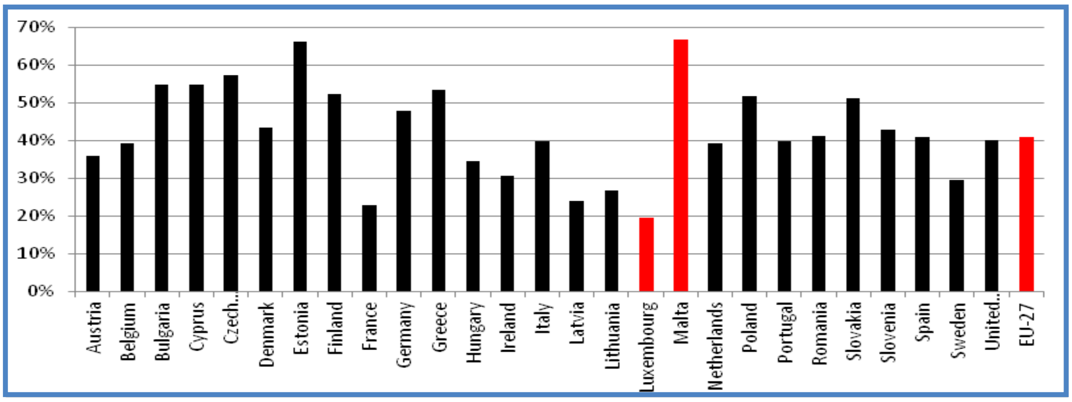
Costs and revenues for the ETS sectors during the ETS second phase (Mln €)



Source: EEA, CITL, Pointcarbon (Appendix II)

FIGURE 3

ETS emissions share: Average percentage of national emissions covered by the ETS 2005-2009



Source: European Environmental Agency and Community International Transaction Log

mate which part of the **national emissions reduction burden** –gap between national emissions and the Kyoto targets- has been allocated to the ETS sectors. A simple index –we can call it the **"ETS emissions reduction index"**- can help us to understand how far Member States rely on the ETS to achieve the Kyoto targets (for major details see Appendix V).

$$\textbf{ETS emissions reduction index} = \frac{\textbf{ETS emissions reduction burden}}{\textbf{ETS emissions share}}$$

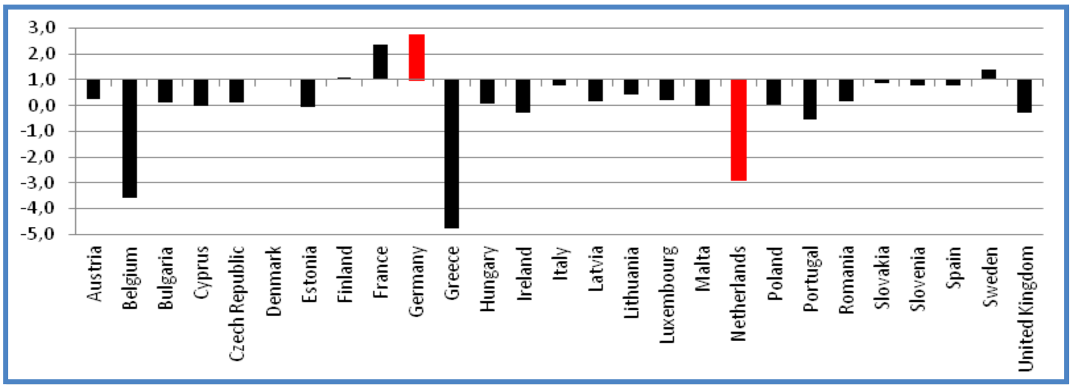
The **ETS emissions reduction index** equals 1 when a Member State imposes on their ETS sectors an emissions reduction burden proportional to the national ETS emissions share. It is lower than 1 when the ETS sectors have to abate an amount of emissions less proportional than their ETS emissions share, while it is higher than 1 otherwise. [Figure 4]

Results reported in figure 4 suggest that:

There is no harmonization. The ETS emissions reduction index is strongly heterogeneous among Member States since the ETS reduction burden (weighted by the respective ETS share) varies significantly across countries. For instance, in Germany, the ETS

Figure 4

ETS emissions reduction Index



Source: own elaboration on tables in Appendix V

emissions reduction index is greater than 1, implying that the ETS sectors are required to reduce an amount of emissions more proportional than the share of produced emissions while in the Netherlands the ETS emissions reduction index is negative because ETS sectors have to reduce a percentage of the national reduction burden lower than the ETS share. Indeed, Dutch ETS sectors were allowed to increase their emissions while the country had to reduce them.

Somebody gains, somebody loses. Despite being subjected to the same European regulation, national firms and sectors faced different reduction efforts depending on the country in which they are located. Some agents bore a cost in order to reduce their emissions or buy allowances to cover their emissions gap, while others that received more permits than they needed could increase their emissions at no cost or they could gain money by selling their surplus of allowances. This unlevel playing field has distorted competition, creating undesirable economic consequences at the expense of effective EU common market integration.

Member States do not rely on the ETS. On average the ETS emissions reduction index is lower than 1, meaning that the reduction burden imposed on ETS sectors has been too weak.[9] The ETS is not enough, and the Kyoto target will be achieved only if non trading sectors abate emissions more proportionally than their emissions share. We develop this point in the next paragraph.

4.1 Achieving Kyoto (with a little help from the ETS)

In 2009 EU-15 emissions were 12.7% lower than 1990 emissions while in 2010 they were 10.7% lower than 1990, thus -2.7% below the EU-15 Kyoto target.[10] Nevertheless, compliance with the Kyoto commitment is not automatically ensured. The ETS drastically changes the picture. In fact, while EU-15 emissions were 82 Mton lower than the -8% Kyoto target in 2010, ETS emissions were 98 Mton lower than the EU-15 ETS cap. This 98 Mton surplus of allowances constitutes a private asset which cannot be taken into account at a national level to calculate distance from Kyoto. Indeed, the ETS sectors' contribution to Kyoto is fixed, and it corresponds to the ETS cap, no matter how many emissions they effectively produce. Thus, the national distance from Kyoto has to be

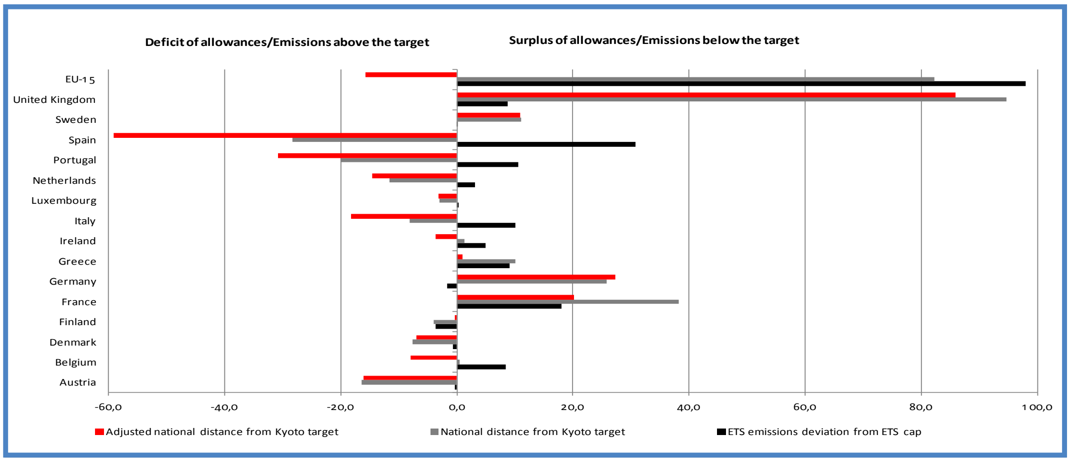
9 The emissions reduction burden imposed on the ETS sectors is less, compared with the burden on non-trading sectors, relative to their share of national emissions.

10 The KP has been ratified in 2002, before the EU enlargement, thus the -8% Kyoto target refers to the former EU-15 Member States

adjusted by excluding any ETS emissions deviation from the ETS cap. It follows that EU-15 Member States have still to abate 16 Mton emissions (82 Mton – 98 Mton) in order to comply with Kyoto, despite aggregate (ETS + non-ETS) emissions already being below national targets, as shown in the figure below (for more details see Appendix VI)

Figure 5

National, ETS and non-ETS distance from their targets in 2010 (Mton)

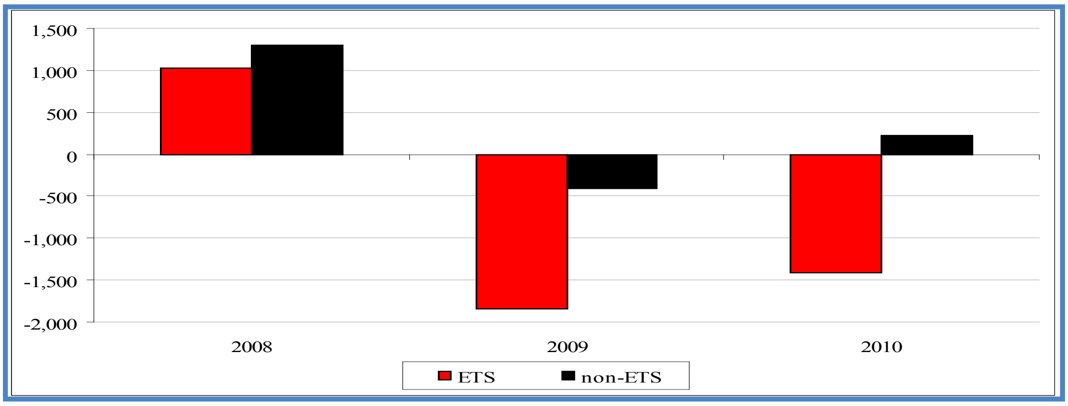


Source: own elaboration from CITL and EEA

The data clearly reveals widespread protectionist policies: Member States preferred to protect national industries by setting soft ETS caps. This had significant redistributive consequences since a higher ETS cap reduces the amount of emissions the ETS sectors have to abate, lowering the cost for the ETS, while increasing both the reduction target imposed on the non-ETS sectors and their compliance costs. By doing so, not only Member States failed to implement the ETS efficiently, but they also indirectly subsidized private sectors with public funding, as governments are going to pay directly for the emissions the non-ETS sectors will not manage to reduce.

Figure 6

EU15 ETS and non-ETS market positions during the period 2008-2010 (Mln €)



Source: own elaboration on tables in Appendix VI

The ETS was expected to facilitate the achievement of EU emissions reduction targets at minimum compliance cost. To the contrary, both in the first trading period and in 2009 and 2010 the ETS sectors could profit from the system, while imposing a greater costs on the non-ETS sectors.

5. ETS and incentives to reduce emissions

During the first phase, ETS emissions did not decrease, on the contrary they increased by 2.1% against a higher GDP growth rate.[11] Not too bad, since it has been estimated that, without the ETS, emissions produced by the regulated sectors would have been even higher (Ellerman and Buchner 2006).

During the second phase, ETS emissions decreased drastically, but it has been extensively argued how this reduction was induced by the economic crisis rather than by effective European climate policy.

To establish how effective the ETS has been in promoting a reduction of emissions, it can be useful to assess whether the carbon price has been sufficiently high to induce a switch between the coal plants and the gas fired plants for supply to the electricity market.

Given real gas and coal prices, it is possible to calculate the theoretical carbon price that would make power companies indifferent to generate electricity using the two fuels. This indicator is called **theoretical coal-to-gas indifference switch price**.

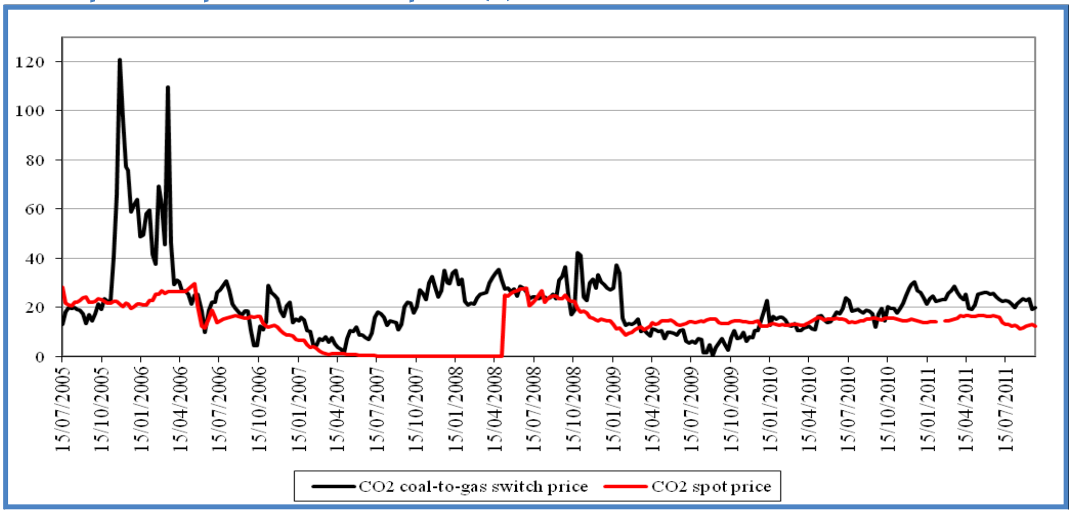
Whenever the real carbon price is higher than the coal-to-gas switch price, burning gas is more economical than using coal. The amount of emissions released to generate electricity decreases, and it is possible to conclude that the ETS is creating effective incentives for reducing emissions in the electricity generation market by promoting a switch of production toward less carbon-intensive fuels.

Vice versa, whenever the CO_2 price is lower than the theoretical coal-to-gas switch price, then the ETS has failed to give an incentive to reduce emissions via fuel switching.

The next figure compares the real and the theoretical CO_2 prices, while Appendix VII illustrates how the theoretical CO_2 coal-to- gas price has been calculated.

FIGURE 7

Switch price and price of EUAs compared (€)



Source: own elaboration on Pointcarbon and Bluenext (carbon price), Platts (coal price), World Gas Intelligence and APX Endex (gas price)

Not surprisingly, during most of the first ETS pilot trading period (2005–2007) the CO_2 real price was lower than the switch price, implying the ETS failed to promote emissions

11 In the Eurozone the EU-25 GDP increased almost by 7% during the same period

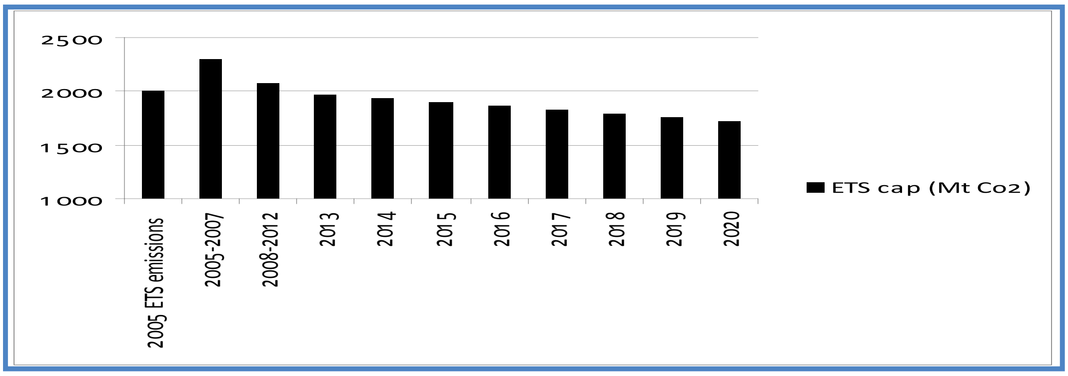
reduction through fuel switching. A similar trend is found also in the second trading period (2008-2010). However, in 2009 the switch price has been lower than the real carbon price for a quite long period, thus favoring a fuel switch from coal to gas. Our analysis reveals that during the seven years of ETS, fuel switching has been supported by the carbon price for almost one and a half years - 85 weeks- corresponding to a reduction of emissions of 193 Mton in the whole period for ETS (1,6% of verified emissions). The analysis confirms that the ETS failed to give any meaningful incentive to abate emissions.

6. Back to the future: what should we expect from the third ETS trading period?

The ETS is expected to improve during its third trading period 2013-2020. In fact, the ETS history is full of ex-post adjustments aimed at correcting previous mistakes and improving the ETS performance. In particular, separated emissions reduction targets have been assigned to the ETS sectors (-21% emissions compared to 2005) and to the non-ETS sectors (-10% emissions compared to 2005), reducing the risk of cross-subsidization among sectors. The ETS cap for the whole 2013-2020 period has been set at a centralized level directly by the Commission to impede Member States from adopting free-riding behaviour and protectionist policies. Indeed, the ETS cap will be reduced each year compared to ETS historical emissions, increasing the emissions reduction burden.[12]

FIGURE 8

ETS cap during the third trading period 2013-2020 (Mton)



Moreover, the new ETS Directive 2009/29/EC establishes a change in the allocation rule: the power sector, which represents almost 60% of the ETS, will have to acquire allowances in a public auction. The progressive move toward auctioning will guarantee significant revenues, similar to the fiscal revenues generated by a carbon tax.

The resources dedicated to European climate policy is going to increase, getting closer to the Structural Fund Budget (30-50 bln euro) and to the Common Agricultural Policy budget (around 60 bln euro). We can approximately estimate that in 2013 the auctioning of more than 1 billion allowances at 15€/ton carbon price will generate public revenues equal to 15 billion euro. However, assessing with precision the future public revenues from auctioning during the whole period 2013-2020 is almost impossible, as the future carbon price trend depends on too many economic and political uncertain-

12 The ETS cap will decrease by 1.74% each year, passing from 1.974 Mton in 2005 to 1.720 Mton in 2020. The inclusion of new sectors within the ETS requires an increase of the cap for the year 2013, which has been determined at just under 2.04 billion allowances.

ties.[13] At the time of adopting the Climate Package the average carbon price during the ETS third trading period was estimated at 30€/ton by the Commission; after the crisis reduced ETS emissions and generated a surplus of allowances –part of which will be transferred into the third phase- the carbon price average value is expected to decrease from 30€/ton to 16€/ton. After Germany announced the progressive phase out of nuclear power generation (which will be partly replaced by more carbon intensive plants), analysts forecasted a carbon price increase toward 40€/ton, while the impact assessment of the proposed Energy Efficiency Directive estimated that the carbon price could fall below EU14 ton or even toward zero if all the potential savings from energy efficiency interventions are realized. We can translate the complicated forecasts into a simple message: too many political and economic uncertainties affect the third ETS trading period; as a consequence, analysts have little clue about the future trend of the ETS carbon price and they continue to adjust their forecasts. Market operators do not know whether investing in low-carbon technology will be a profitable strategy. Member States do not know the value of revenues they will receive from public auctions. There is, however, plenty of room for financial activity and speculation.

7. Are ex-post interventions an effective solution?

From its very beginning, the ETS has been characterized by very high carbon price volatility - influenced by both market and regulatory uncertainties – and it has experienced several unexpected price reductions, allowing the ETS installations to comply with the ETS without having to invest in low-carbon technologies. In spite of some improvements, the picture is not likely to change drastically during the next trading period.

High and stable carbon prices are required to foster investments in low carbon technologies, which otherwise would fail to penetrate the market. To the contrary, during the third trading period 2013-2020 the ETS may fail to support low carbon technologies, as the carbon price is expected to be too low and unstable to make low carbon investments convenient and profitable.[14]

In light of this shortcoming, on different occasions the European Commission has proposed to reduce the ETS cap through ex-post administrative interventions in order to support the carbon price at a level required to increase the competitiveness of low carbon technologies and foster their diffusion and innovation.

13 Climate Strategies tried to assess the future revenues from auctioning in the period 2013-2020, concluding that these vary between 150-190 billion euro, and could reach even 310 billion euro if the proposal to reduce the ETS target from -21% to -34% compared to 2005 will be approved. This assessment derives from the fact that, as reported by the PRIMES 2010 model, the carbon price is expected to increase from 15 €/ton in 2013 (yearly average) to 25€/ton in 2020 (in 2020 the price could reach 17€/ton in case the 20% renewable sources target will be reached). However, if the ETS target is lowered to -30%, according to the PRIMES model the carbon price could increase to 55€/ton. European Commission (2010), EU energy trends to 2010 - Update 2009, European Commission, Directorate-General for Energy, Brussels e Grubb M., Cooper S. (2011), Revenue dimensions of the EU ETS Phase III, Ed. Climate Strategies.

14 The crisis generated a surplus of allowances which can be banked and transferred to the next trading period, increasing the supply and reducing the demand of allowances. Thus, the European Commission estimated that during the period 2013-2020 the average carbon price will decrease from 30 €/ton to 16€/ton. At this price, investment in low carbon technologies, such as carbon capture and storage, are no longer convenient. As stated directly in the official community document: "The carbon price is now lower than was estimated in 2008, when the climate and energy package was agreed. Furthermore, the carbon price is not expected to recover by 2020 to a level sufficient to drive innovation in new technologies such as carbon capture and storage" Moreover it stated that: "investment in options like carbon capture and storage (CCS) is heavily dependent on the price signal delivered by the carbon market. A lower carbon price acts as a much less powerful incentive for change and innovation".

A strategy paper published in February 2011 by Connie Hedegaard's team at the Commission proposed to "set aside" 500-800 million permits from the amount due to be auctioned in the scheme to counter a potential price slide that would occur following emissions reductions through energy efficiency interventions.[15] In 2010, the European Commission proposed to further decrease the European 2020 emissions target from -20% to -30% to support the carbon price and restore the incentives to innovate.[16]

In order to reduce the uncertainty linked to the unforeseeable carbon price variability, lobby groups and analysts have also proposed to institute an independent Carbon Central Bank to support the carbon price at a certain level by reducing the supply of allowances when prices are in danger of crashing (withholding allowances or reducing the amount of allowances to be auctioned) or increase the flow of permits when the market is overheated.

In few words, the EC is willing to lower ex-post the ETS cap in order to support carbon prices at a desired level. However, these ex-post adjustments risk violating the nature of a cap and trade scheme such as the ETS, undermining the credibility and certainty of EU climate policy. The principle behind a market-based instrument such as the cap and trade scheme is that, given the lack of information concerning the private marginal abatement costs and future market evolution, the regulator limits itself to fix the desired level of emissions that can be produced, letting market agents to freely decide how to reach this desired goal in the most effective way, letting the carbon price naturally adjust according to market evolution. Thus, by adopting a cap and trade system, the regulator is sure to pursue a desired environmental goal (the level of emissions corresponding to the cap), but it cannot impede the carbon market from creating a price that is lower than the level required to make new clean technologies more competitive. It is part of the game.

Under a carbon tax the opposite is true: the emissions price is fixed and certain while the quantity of produced emissions remains uncertain and it will vary depending on economic trends. Therefore, the regulator can achieve an industrial goal by fixing the carbon tax at the level required to support certain technology, but at the same time it cannot impede the installations from emitting as much as they want, as far as they pay the carbon tax, with the risk that the aggregate level of emissions are higher than desired. The main point is that, independently of the chosen market-based instrument, the regulator can fix and control only one of the two economic variables "prices vs quantities", while allowing the market to adjust the other "uncontrolled" economic variable.

When the EC proposes to adjust ex-post the ETS cap to increase the carbon price, it tries to pursue a price goal through a quantity instrument and, in order to do that, it is willing to modify the rules of the game, overcoming the market functioning mechanisms. On top of being administratively costly and politically unreliable, the Commission's strategy is not efficient, simply because the chosen ETS instrument is not the most tailo-

15 According to the Commission's impact assessment of the Energy Saving Directive, EU energy efficiency measures could be so effective in cutting emissions over the next decade that EUA demand could slump and prices fall by 44 per cent to 14€/ton

16 The PRIMES scenario estimates that the CO_2 price would almost double and its annual average during the decade 2010-2020 would pass from 16€/ton to 30€/ton, thus making convenient the development of new innovative technologies – such as the Carbon Capture and Storage – and favoring the moving toward a low carbon economy. According to the EC "the lower cost of meeting the 20% target and the lower than expected carbon prices in the EU ETS have reduced the incentives for innovation generated by the climate and energy package. Moving to a 30% target would restore these incentives" (EC 2010b, p. 4).

red market-based instrument to create a stable price at the level required to stimulate technological innovation and the adoption of low-carbon technologies.

8. Opting for a carbon tax

Fixing with certainty the carbon price at a high and stable level reduces the uncertainties related to the marginal production costs and increases expected profits for adoption of low-carbon technology. This is an important condition for stimulating long-term investments.

Of course, controlling both the price and quantity of emissions is impossible, therefore, with a fixed carbon price the future amount of European emissions remains uncertain. However, European emissions represent a negligible part of global emissions and the reduction of European emissions cannot impact significantly on the trend of global emissions. It is sufficient to observe that in 2009, when the European carbon emissions touched the lowest point in recent years, global emissions reached their peak level. Therefore, fixing a carbon price in order to reach an industrial goal (fostering diffusion of low carbon technologies) would appear to be a more effective strategy than fixing the quantity of emissions in order to reach an environmental goal (the emissions reduction target).

Nevertheless, having already opted for a cap and trade scheme, the Commission is now trying to grant price stability and fostering low carbon technologies by intervening indirectly on the ETS cap through ex-post adjustments. Market operators welcome price stability and, given the current normative framework, this strategy seems to be the only politically feasible one. On the other hand, this action increases regulatory and administrative costs, it requires a deep and continuous policy intervention into the ETS, reducing its credibility as a market based instrument.

Looking at the whole picture makes very clear how adopting a cap and trade scheme and intervening ex-post in the workings of the market by adjusting quantities in order to control the carbon price is a very complicated and costly system, thus inefficient, strategy to increase the convenience and competitiveness of low carbon technologies and foster their diffusion. The same goal could be achieved at a lower administrative cost, and without any intrusive public intervention into the market, by opting for a price mechanism: a carbon tax.

Reducing public debt and tax distortions – A carbon tax can play an important role, since it is a non-distortionary instrument that can facilitate the simultaneous achievement of different goals. It grants price stability, fostering the adoption of low carbon technologies and reducing the gap from the 2020 energy and climate targets. A carbon tax can have a positive impact on the public budget, reducing countries' deficit and public debt. It is well known that in many European Member States, Italy among them, public funding to support the financial, banking and industrial systems during the crisis increased public debt, moving countries away from European stability pacts. In the current financial situation, reducing public debts has become a priority and this can be done by rationalizing public expenses and increasing fiscal revenues. In the short term, given the debt crisis, a carbon tax can reduce the deficit and public debt in those countries facing financial instability. In the long-term, distortions would be minimized through revenue neutrality: fiscal revenues from a carbon tax should be used to lower other distortionary taxes (labor taxes): This would reduce deadweight loss and promote economic growth. A cap and trade scheme where only some allowances are auctioned is a second-best option. It cannot create the same public revenues and it fails to support the carbon price at a level required to incentivise emissions reduction via fuel switching and technological innovation.

Increasing harmonization – By imposing an equal tax among ETS and non-ETS sectors, and among industrial and electricity sectors, a carbon tax can lead to enhanced harmonization among economic sectors, reducing the distortions that have been in place with the ETS.[17] If all the sectors had to pay a uniform price proportional to the amount of emissions they produce, higher harmonization would ensue, environmental policy would result in more credible and effective, and market distortions would be reduced. All this could be reached at a lower administrative cost by opting for an easier market-based instrument.[18]

Despite being easier and more effective, a common carbon tax was not introduced in Europe, which preferred to opt for a more complicated and administratively costly cap and trade system. Why is that? Not only because Member States do not want to give up their national fiscal sovereignty to the European Commission. An important argument that could explain the general preference in Europe toward a cap and trade scheme over a tax system comes from the Chicago 'political economic theory of regulation'. The Chicago School tends to stress the failure of regulation, which is likely to be captured and influenced by private interests. Revesez and Stavins (2004) observed that tradable permits have been extensively preferred to taxes. This is because while a tax system implies a transfer of money from the private to the public sector, in a cap and trade scheme, where allowances are (partly) allocated for free, this potential tax revenue is kept by the private installations, implying opposite impacts on public finance. Thus, compared with a carbon tax, a cap and trade scheme where allowances are allocated for free increases the political acceptability of a climate policy (Baumol and Oates 1998; Tietenberg et al. 1999). Nevertheless, a carbon tax has already been introduced in different Member States and a new European Directive proposal intends to harmonised the energy taxation among fuels and sectors (see Appendix VIII for further details).

9. Emissions reduction via a carbon tax

What if a carbon tax were in place instead of the ETS? We first report for how many weeks the switch from coal to gas would have occurred for different carbon tax levels.[19] The results are quite straightforward: during the period 2005-2010 a EU15 ton carbon tax would have favored a switch for 103 weeks, that is 18 switching weeks more than the ones promoted by the ETS (85 weeks). By doubling the carbon tax (EU30ton) the number of switching weeks would more than double: 240 weeks, almost three times the result achieved by the ETS.

17 We have noted that the ETS did not manage to incentivise harmonization among sectors, distorting market competition. Despite being subjected to the ETS, industrial and energy sectors paid different costs depending on the countries in which they were located and because of different allocation criteria; on top of that, Member States could exploit the ETS to protect national industries and translating the environmental costs on non-ETS sectors.

18 Proposals to differentiate the carbon tax among sectors should be avoided as much as the temptation to exempt some particular sectors. These protectionist choices would worsen the effectiveness of the system by lowering internal harmonization and consistency, and would face an enforcement problem from a legal perspective, like experienced in the French case

19 This can be done simply by comparing the hypothetical carbon tax with the coal-to-gas carbon switch price previously calculated

Table 1

Number of switching weeks (Theoretical switch price < carbon tax)

	2005	2006	2007	2008	2009	2010	2005-2010	Weeks (Carbon Tax-ETS)
Carbon tax = 15€	3	7	31	0	45	17	103	18
Carbon tax = 20€	13	15	38	2	47	42	157	72
Carbon tax = 25€	17	23	44	19	47	48	198	113
Carbon tax = 30€	17	36	49	36	50	52	240	155
ETS carbon price	14	9	0	8	39	15	85	0

Sources: own elaboration on Bluenext, Platts, ICE data

To assess how far emissions would have been abated for different carbon tax levels we restrict our simulation to the electricity sectors in the some European Member States.[20] For each of these countries, we consider the gas plant's power generation capacity (MW) and we assess their maximum gross power generation (MWh), that is the maximum amount of electricity the gas plants would have produced if they were running at the best of their capabilities. Then we compare it with the gas plants' historical gross power generation (MWh). This difference constitutes a technical constraint: the maximum amount of electricity produced by coal plants that can be replaced by gas plants. We call this variable the **"gas plants' residual gross power generation capability"** (see Appendix IX table 21) and we compare it with the coal plants' historical gross power generation (weekly data). The difference between these two variables indicates the maximum weekly electricity switch from coal to gas.

Table 2

Maximum weekly power generation switch from coal to gas 2005-2007 (GWh)

	2005			2006			2007		
	Coal power generation	Gas residual power generation	Max weekly switch	Coal power generation	Gas residual power generation	Max weekly switch	Coal power generation	Gas residual power generation	Max weekly switch
France	529	122	122	440	140	140	470	160	160
Germany	5.722	712	712	5.648	652	652	5.260	783	783
UK	2.589	746	746	2.869	1.016	1.016	2.626	538	538
Italy	839	979	839	850	1.520	850	848	1.473	848
Poland	2.734	24	24	2.833	31	31	2.773	29	29
Total			**2.442**			**2.689**			**2.358**

Italy is the only country where the existing gas plants' generation capacity could totally replace the power generation from coal plants. In the other countries gas plants could replace only part of the coal power generation (the gas residual gross electricity generation). By combining the maximum switching weeks for given carbon tax levels with the maximum amount of coal plants' generated electricity that could be replaced by gas plants, we can finally assess how many emissions would have been *further* reduced if a carbon tax were in place instead of the ETS. This simulation can be done for different levels of a carbon tax and it is reported in the figure 9 below.

This simulation reports the emissions reductions induced by different levels of a carbon tax in addition to abatement via fuel switching promoted by the ETS. Positive bars imply the carbon tax would have favored further fuel switching in respect to ETS (additional

20 France, Germany, United Kingdom, Italy and Poland. The overall emissions produced by the electricity sectors in these countries represents 65% of the ETS electricity sectors' emissions

TABLE 3

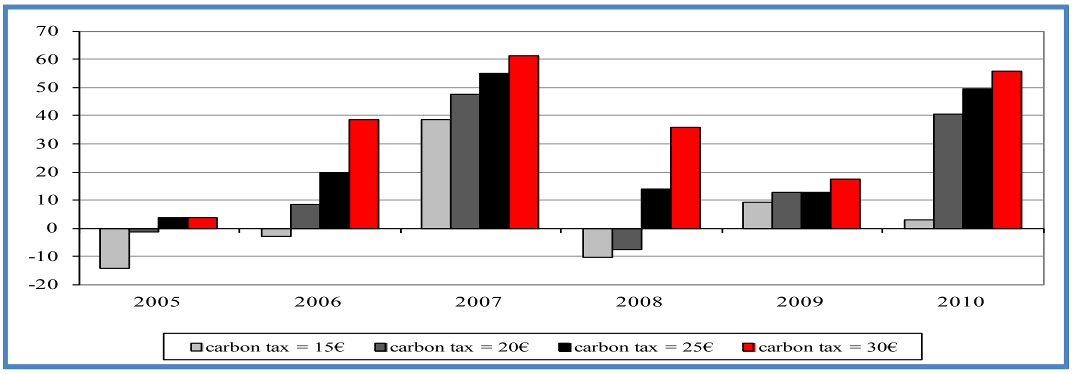
Maximum weekly power generation switch from coal to gas 2008-2010 (GWh)

	2008			2009			2010		
	Coal power generation	Gas residual power generation	Max weekly switch	Coal power generation	Gas residual power generation	Max weekly switch	Coal power generation	Gas residual power generation	Max weekly switch
France	443	169	169	498	201	201	422	306	306
Germany	5.293	1.058	1.058	4.830	1.278	1.278	4.997	726	726
UK	2.411	340	340	2.012	711	711	2.436	827	827
Italy	828	1.577	828	764	2.455	764	940	2.312	940
Poland	2.672	27	27	2.566	21	21	2.865	41	41
Total			**2.422**			**2.975**			**2.841**

Sources: DG Energy "EU energy trends to 2030 - update 2009", DG Energy "Countries factsheet". See Appendix IX

FIGURE 9

Further emissions reduction via fuel switching with a carbon tax instead of the ETS (Mton)



Sources: own elaboration on DG Energy "EU energy trends to 2030 - update 2009", DG Energy "Countries factsheet", Pointarbon, Platts and ICE data

number of weeks), while negative bars imply that a carbon tax would have favored fuel switching for a lower number of weeks compared with the ETS (see Appendix IX for further information).

The simulation reveals that, on top of the 193 Mton emissions reduction via fuel switching promoted by the ETS (see paragraph 4), during the whole period 2005-2010 a carbon tax would have further reduced carbon emissions (in addition to the ETS) from a minimum of 24 Mton (carbon tax equal to EU15 ton) to a maximum of 212 Mton (carbon tax equal to 30€/ton); an average reduction in emissions that varies between 4 Mton/year (0,4% reduction) and 35 Mton/year (3,8% reduction). This data refers to the electricity sectors of the 5 Member States considered in the simulation, representing the 65% of the emissions produced by the ETS electricity sector. By hypothetically extending our results to the whole ETS electricity sector, it follows that during the period 2005-2010 a carbon tax would have encouraged a further reduction of emissions in the ETS electricity sector from 7 Mton/year with a 15€/ton carbon tax –almost 1% of their emissions- to 65 Mton/year with a EU30 ton carbon tax (4% of the emissions).

Table 4

Emissions reduction in the ETS electricity sector from fuel switching with a carbon tax (Mton)

	2005	2006	2007	2008	2009	2010	Total period 2005-2010	Yearly Reduction
Carbon tax = 15 €	-22	-4	60	-16	15	5	37	7
Carbon tax = 20 €	-2	13	73	-12	19	63	154	31
Carbon tax = 25 €	6	31	85	22	19	76	239	48
Carbon tax = 30 €	6	59	94	55	27	86	327	65

Sources: own elaboration on DG Energy "EU energy trends to 2030 - update 2009", DG Energy "Countries factsheet", Pointcarbon, Platts and ICE data

10. Conclusions

In this paper we have first assessed the effectiveness of the EU ETS in promoting emissions reduction and achieving Kyoto emissions reduction targets. The comparison between the carbon price and the theoretical coal-to-gas fuel switch price reveals that during the period 2005-2011 the carbon price promoted emissions reduction via fuel switching for only almost one and a half years, failing to give long-term and stable incentives to abate emissions. The analysis highlights that the ETS caused many inefficiencies and market distortions. Despite being subjected to the same European regulations, national firms and sectors faced different reduction efforts depending on the country in which they are located. Some agents were faced with a cost to reduce their emissions or had to buy allowances to cover their emissions gap, while others received more permits than they needed and could increase their emissions at no cost, or gain money by selling their surplus of allowances. This lack of a level playing field has distorted competition, creating undesirable economic consequences at the expense of effective EU common market integration. The analysis clearly reveals that Member States preferred to protect national industries by setting a soft ETS cap rather than imposing them an effective emissions reduction according to their abatement opportunities. Protectionism in favor of the ETS sectors had significant redistributive consequences. By imposing soft ETS caps at a national level, Member States failed to implement the ETS efficiently and indirectly subsidized private sectors with public funding, as governments are going to pay directly for the emissions the non-ETS sectors are not able to reduce. The ETS was expected to facilitate the achievement of the EU emissions reduction targets at the minimum compliance cost. To the contrary, both in the first trading period and in 2009 and 2010 the ETS sectors could profit from climate regulation, while imposing a more proportional cost on non-ETS sectors.

The second part of the paper explains why most of the ETS related inefficiencies would be avoided by opting for a carbon tax and it assesses the further reduction of emissions that would have been promoted if a carbon tax were in place instead of the ETS. A carbon tax of EU15 ton would have promoted higher emissions reductions in the electricity sector via fuel switching than the ETS; a price control mechanism would reduce market distortions and it would ensure higher harmonization among sectors, avoiding inefficient forms of cross-subsidization. Member States' opportunity to free ride on other countries' efforts by adopting protectionist policy in favour of national industries would be avoided. Moreover, a carbon tax would constitute the easiest and cheapest instrument to support the competitiveness of low carbon technologies, fostering their diffusion and innovation. Granting carbon price stability at a high level within the ETS by adjusting the ETS cap ex-post represents a second-best option. Not only does it imply higher regulatory and administrative costs, it also requires a deep and continuous policy intervention into the ETS, damaging its credibility as market based instrument.

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Appendix I – ETS market during the first phase

During the overall first ETS trading period ETS sectors received 6.247 million permits in total, while they had to surrender 6.105 million permits, as the amount of emissions they produced during the three years. Thus, each year ETS sectors held at an aggregate level a surplus of allowances received at no cost that they could sell within the ETS at the market price (the yearly average value passed from EU18,3ton in 2005, to EU17,2 ton in 2006 to almost zero in 2007). The sum of the profits that the ETS sectors received from selling their surplus has a value of EU2,135 Billion each year. Of course, not all the installations held a surplus of allowances; some firms were net sellers while others were net buyers. Thus the ETS caused significant redistributive effect among European sectors. During the three years, had to buy 48 million permits for EU263 million, while the industry's aggregate surplus of 189 million permits brought profits for EU2.411 million.

Table 5

2005-2007 EU-25 ETS cap and emissions (Mton co2)

	ETS cap (Mton)	ETS verified emissions (Mton)	Surplus of Allowances (Mton)	Yearly average price (€/ton)	Profit (€/ton)
2005	2096	2014	82	18,3	1508,4
2006	2072	2036	36	17,2	625,8
2007	2079	2056	23	0,6	13,6
2005-2007	6247	6105	141	-	2148

Source: EEA, CITL, Pointcarbon

Table 6

Power and industry's market position during the ETS first phase

	2005					2006				
	Allocation (Mton)	Verified Emissions (Mton)	Surplus Deficit (Mton)	carbon price (€/ton)	Profit/ Cost (Mln €)	Allocation (Mton)	Verified Emissions (Mton)	Surplus Deficit (Mton)	carbon price (€/ton)	Profit/ Cost (Mln €)
Power	1.469	1.459	10		178,0	1.446	1.471	-24		-421,3
Industry	627	555	73	18,3	1330,4	625	565	60	17,33	1047,1
total	2.096	2.014	82		1508,4	2.072	2.036	36		625,8

Source: EEA, CITL, Pointcarbon

Appendix II – ETS market trends during the second phase

With the financial crisis the price passed from EU29 ton on September 2008 to 9 €/ton on February 2009 (-69%). On yearly average, the price passed from EU22 ton in 2008, to 13 /ton in 2009 (-40%), and to 14,3 €/ton in 2010 (+9%).

By comparing the amount of allocated allowances with the verified emissions we observe that ETS sectors realized an aggregate surplus of 105,7 Mton in 2009 and 66,8 Mton in 2010: 173 Mton in two years. Monetized at the observed carbon price, this surplus corresponded to EU2.358 million of profit for the ETS sectors.

Table 7

Power and industry's market position during the ETS second phase

	2007					2005-2007			
	Allocation (Mton)	Verified Emissions (Mton)	Surplus Deficit (Mton)	carbon price (€/ton)	Profit/ Cost (Mln €)	Allocation (Mton)	Verified Emissions (Mton)	Surplus Deficit (Mton)	Profit/ Cost (Mln €)
Power	1.451	1.484	-33		-19,8	4.366	4.414	-48	-263
Industry	628	572	56	0,65	33,4	1.881	1.692	189	2.411
total	2.079	2.056	23		13,6	6.247	6.105	141	2.148

Source: EEA, CITL, Pointcarbon

Appendix III - Installations and transaction costs

The distribution of installation operating within the ETS is extremely polarized: while 8% of ETS installations produce more than 80% of the ETS emissions, almost 40% of ETS installations produce less of 2% of ETS emissions. Therefore many small installations did not manage to benefit from the ETS surplus opportunity because of the substantial transaction costs (legal cost, risk management, brokering and trading) they need to support to trade allowances in the financial market. According to estimations, variable transaction costs can vary among countries and the size of firms; on average they equal EU35.000 a year, while smaller emissions class firms pay around EU16.000. Despite being lower in absolute terms, transaction costs weigh more on smaller firms (EU2 for produced emissions) than on higher ones (EU0.05 for each produced emissions).[21]

Table 8

Distribution of installations and emissions (Average 2005-2010)

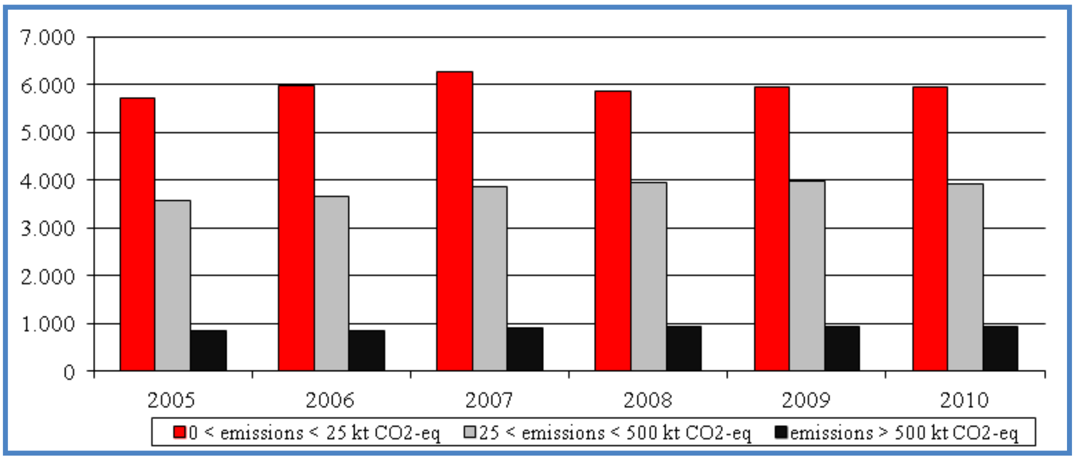
	2008					2009				
	Allocation (Mton)	Verified Emissions (Mton)	Surplus Deficit (Mton)	carbon price (€/ton)	Profit/ Cost (Mln €)	Allocation (Mton)	Verified Emissions (Mton)	Surplus Deficit (Mton)	carbon price (€/ton)	Profit/ Cost (Mln €)
Power	1.255	1.496	-241		-5383	1.265	1.366	-101		-1331
Industry	695	604	91	22,3	2032	701	494	207	13,2	2728
total	1.950	2.100	-150		-3351	1.966	1.860	106		1397

Source: elaboration on CITL

21 Betz R., Sanderson T., Ancev T. (2009), In or out: efficient inclusion of installations in an emissions trading scheme? Journal of Regulation Economics , Volume 37, Number 2, 162-179, Graus, W., & Voogt, M. (2007). Small installations within the EU Emissions Trading Scheme. Report under the project "Review of EU Emissions Trading Scheme", ECS04079. Report commissioned by the European Commission Directorate General for Environment, Brussels, Jaraite J., Convery F., Di Maria C. (2010) Assessing the transaction costs of firms in the EU ETS: lessons from Ireland, Climate Policy 10(2) p:190-215

FIGURE 10

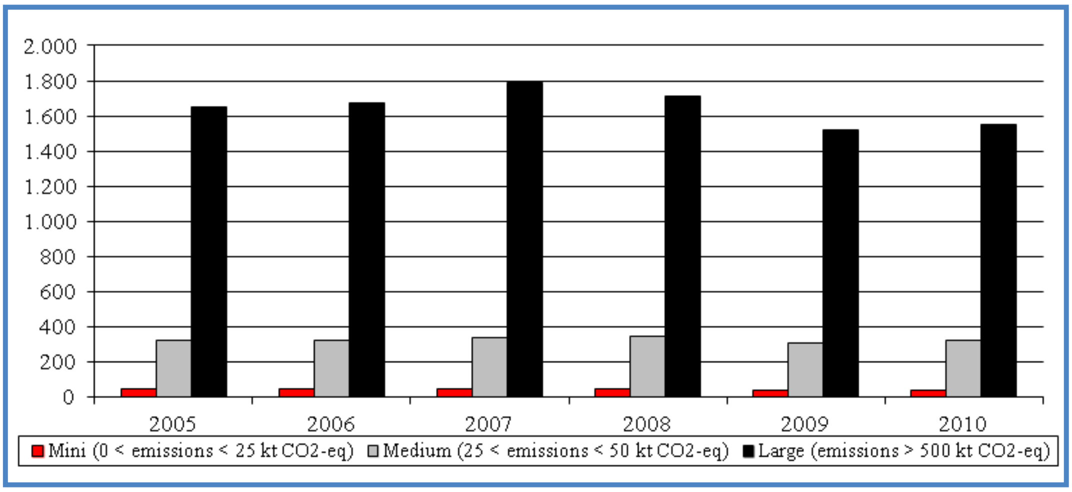
Number of installations for emissions classes



Source: elaboration on CITL

FIGURE 11

Verified Emissions per emissions classes (Mton)



Source: elaboration on CITL

Appendix IV – the ETS emissions share

The percentage of national emissions covered by the ETS sectors can be easily calculated by combining the ETS verified emissions (Tab.9) with the national verified emissions (Tab.10) and by calculating the ratio (Tab. 11).

TABLE 9

ETS verified emissions (Mt CO2-eq)

	2005	2006	2007	2008	2009
Austria	33,4	32,4	31,8	32,0	27,3
Belgium	55,4	54,8	52,8	55,5	46,2
Bulgaria	-	-	39,2	38,3	32,0
Cyprus	5,1	5,3	5,4	5,6	5,4
Czech Republic	82,5	83,6	87,8	80,4	73,8
Denmark	26,5	34,2	29,4	26,5	25,5
Estonia	12,6	12,1	15,3	13,5	10,3
Finland	33,1	44,6	42,5	36,2	34,3
France	131,3	127,0	126,6	124,1	111,1
Germany	475,0	478,0	487,1	472,7	428,2
Greece	71,3	70,0	72,7	69,9	63,7
Hungary	26,2	25,8	26,8	27,2	22,4
Ireland	22,4	21,7	21,2	20,4	17,2
Italy	226,0	227,4	226,4	220,7	184,9
Latvia	2,9	2,9	2,8	2,7	2,5
Lithuania	6,6	6,5	6,0	6,1	5,8
Luxembourg	2,6	2,7	2,6	2,1	2,2
Malta	2,0	2,0	2,0	2,0	1,9
Netherlands	80,4	76,7	79,9	83,5	81,0
Poland	203,1	209,6	209,6	204,1	191,2
Portugal	36,4	33,1	31,2	29,9	28,3
Romania	-	-	69,6	64,1	49,0
Slovakia	25,2	25,5	24,5	25,3	21,6
Slovenia	8,7	8,8	9,0	8,9	8,1
Spain	183,6	179,7	186,6	163,5	136,9
Sweden	19,4	19,9	19,0	20,1	17,5
United Kingdom	242,5	251,2	256,6	265,1	232,0
EU-27	2014,0	2035,7	2164,7	2100,2	1860,1

Source: European Environmental Agency data viewer, Community International Transaction Log

Next page: table 10 (above) and Table 11 (below)

TABLE 10

National verified emissions (Mt CO2-eq)

Source: European Environmental Agency data viewer

TABLE 11

Share of National emissions covered by the ETS

Source: European Environmental Agency data viewer

	2005	2006	2007	2008	2009
Austria	92,9	90,1	87,4	87,0	80,1
Belgium	142,7	137,7	132,9	135,2	124,4
Bulgaria	67,1	68,3	71,8	69,0	59,5
Cyprus	9,6	9,7	9,9	10,2	9,4
Czech Republic	144,7	146,0	147,1	141,1	132,9
Denmark	63,6	71,6	66,9	63,7	61,0
Estonia	19,2	18,7	21,6	20,1	16,8
Finland	68,5	79,7	78,1	70,4	66,3
France	569,0	553,0	544,5	539,2	517,2
Germany	999,8	1002,3	979,9	981,1	919,7
Greece	134,4	130,7	133,4	128,6	122,5
Hungary	79,5	77,8	75,5	73,1	66,7
Ireland	69,2	68,7	68,0	67,8	62,4
Italy	574,9	563,9	554,6	541,7	491,1
Latvia	11,4	11,8	12,3	11,9	10,7
Lithuania	22,6	23,4	25,1	24,0	21,6
Luxembourg	13,2	13,0	12,4	12,3	11,7
Malta	2,9	3,0	3,0	3,0	2,9
Netherlands	211,1	207,1	205,4	204,6	198,9
Poland	388,0	402,3	400,7	395,7	376,7
Portugal	86,0	81,3	79,1	77,9	74,6
Romania	155,7	160,4	156,2	153,4	130,8
Slovakia	50,1	49,9	47,8	48,2	43,4
Slovenia	20,2	20,5	20,6	21,3	19,3
Spain	433,8	426,0	437,1	404,8	367,5
Sweden	67,6	67,3	65,8	63,6	60,0
United Kingdom	651,0	644,6	634,2	620,3	566,2
EU-27	5150,8	5130,9	5073,3	4971,1	4616,5

	2005	2006	2007	2008	2009	Average
Austria	36%	36%	36%	37%	34%	36%
Belgium	39%	40%	40%	41%	37%	39%
Bulgaria	-	-	55%	55%	54%	55%
Cyprus	53%	54%	55%	55%	57%	55%
Czech Republic	57%	57%	60%	57%	56%	57%
Denmark	42%	48%	44%	42%	42%	43%
Estonia	66%	65%	71%	67%	61%	66%
Finland	48%	56%	54%	51%	52%	52%
France	23%	23%	23%	23%	21%	23%
Germany	48%	48%	50%	48%	47%	48%
Greece	53%	54%	55%	54%	52%	53%
Hungary	33%	33%	36%	37%	34%	35%
Ireland	32%	32%	31%	30%	28%	31%
Italy	39%	40%	41%	41%	38%	40%
Latvia	25%	25%	23%	23%	23%	24%
Lithuania	29%	28%	24%	25%	27%	27%
Luxembourg	20%	21%	21%	17%	19%	19%
Malta	67%	67%	67%	67%	66%	67%
Netherlands	38%	37%	39%	41%	41%	39%
Poland	52%	52%	52%	52%	51%	52%
Portugal	42%	41%	39%	38%	38%	40%
Romania	-	-	45%	42%	37%	41%
Slovakia	50%	51%	51%	53%	50%	51%
Slovenia	43%	43%	44%	42%	42%	43%
Spain	42%	42%	43%	40%	37%	41%
Sweden	29%	30%	29%	32%	29%	30%
United Kingdom	37%	39%	40%	43%	41%	40%
European Union	39%	40%	43%	42%	40%	41%

Appendix V– the ETS emissions reduction Index

The ETS emissions reduction index is given by the ratio between ETS emissions reduction burden and the ETS emissions share:

$$\textbf{ETS emissions reduction index} = \frac{\textbf{ETS emissions reduction burden}}{\textbf{ETS emissions share}}$$

The ETS share is the percentage of national emissions covered by the ETS sectors, as previously estimated. **The ETS emissions reduction burden** is the percentage of the national emissions reduction burden allocated to the ETS sectors. The ETS emissions reduction burden can be estimated as the ratio between the *ETS emissions gap* and the respective *national emissions gap* where: a) *ETS emissions gap* for each country is given by the difference between the 2008-2012 ETS cap and the ETS historical emissions

TABLE 12

ETS emissions gap: ETS emissions - ETS cap (Mton)

	ETS cap (average 2008-2012)	ETS emissions (average 2005-2007)	ETS Emissions gap
Austria	30,7	32,5	-2
Belgium	58,5	54,3	4
Bulgaria	42,3	39,2	3
Cyprus	5,5	5,2	0
Czech Republic	86,8	84,6	2
Denmark	24,5	30,0	-6
Estonia	12,7	13,4	-1
Finland	37,6	40,1	-2
France	132,8	128,3	5
Germany	453,1	480,1	-27
Greece	69,1	71,3	-2
Hungary	26,9	26,3	1
Ireland	22,3	21,8	1
Italy	201,6	226,6	-25
Latvia	3,4	2,9	1
Lithuania	8,8	6,4	2
Luxembourg	2,5	2,6	0
Malta	2,1	2,0	0
Netherlands	87,5	79,0	9
Poland	208,5	207,5	1
Portugal	34,8	33,6	1
Romania	75,9	69,6	6
Slovakia	32,6	25,1	8
Slovenia	8,9	8,3	-1
Spain	183,3	152,3	-31
Sweden	19,4	22,8	3
United Kingdom	250,1	246,2	-4

Source: ETS emissions from EEA ETS data viewer; cap ETS from EEA "Greenhouse gas emission trends and projections in Europe 2009" tab. 5.3

levels (last column of Table. 12), while b) *national emissions gap* is given by the difference between the national Kyoto targets and the respective national historic emissions levels[22] (last column of Tab.13). To make them comparable, national and ETS emissions

22 With the ratification of the Kyoto Protocol, the EU committed to reduce by 2012 its greenhouse gas

gaps are estimated from the 2005-2007 average emissions data, because only from 2005 can we rely on official and reliable data on the emissions produced by the ETS; such information was not available for the previous years.

Table 13

National emissions gap: National emissions - the Kyoto targets (Mton)

	KYOTO TARGET		National emissions (average 2005-2007)	National emissions gap
Austria	-13,0%	68,8	90,1	-21,3
Belgium	-7,5%	134,8	137,8	-3,0
Bulgaria	-8,0%	122,0	69,1	52,9
Cyprus	-	-	9,7	-
Czech Republic	-8,0%	178,7	145,9	32,8
Denmark	-21,0%	54,8	67,4	-12,6
Estonia	-8,0%	39,2	19,8	19,4
Finland	0,0%	71,0	75,4	-4,4
France	0,0%	563,9	555,5	8,4
Germany	-21,0%	973,6	994,0	-20,4
Greece	25,0%	133,7	132,8	0,9
Hungary	-6,0%	108,5	77,6	30,9
Ireland	13,0%	62,8	68,6	-5,8
Italy	-6,5%	483,3	564,5	-81,2
Latria	-8,0%	23,8	11,9	11,9
Lithuania	-8,0%	45,5	23,7	21,8
Luxembourg	-28,0%	9,5	12,9	-3,4
Malta	-6,0%	-	3,0	-
Netherlands	-6,0%	200,3	207,9	-7,6
Poland	27,0%	529,6	397,0	132,6
Portugal	-8,0%	76,4	82,1	-5,7
Romania	-	256,0	157,5	98,5
Slovakia	-8,0%	66,3	49,3	17,0
Slovenia	-8,0%	18,7	20,4	-1,7
Spain	15,0%	333,2	432,3	-99,1
Sweden	4,0%	75,0	66,9	8,1
United Kingdom	-12,5%	679,3	643,3	36,0

Source: Kyoto target from European Environmental Agency "Greenhouse gas emission trends and projections in Europe 2009" tab. 12.1; National emissions from EEA data viewer

emissions 8% below the 1990 emissions level. With the *Burden Sharing Agreement* the European target has been partitioned across countries and then extended to the new Member States.

Table 14

ETS emissions reduction burden (ETS emissions gap/National emissions gap)

	ETS emissions reduction burden
Austria	8,5%
Belgium	-140,0%
Bulgaria	5,9%
Cyprus	-
Czech Republic	6,6%
Denmark	44,0%
Estonia	-3,4%
Finland	56,0%
France	53,5%
Germany	132,3%
Greece	-255,5%
Hungary	2,0%
Ireland	-8,6%
Italy	30,8%
Latvia	4,3%
Lithuania	11,1%
Luxembourg	3,8%
Malta	-
Netherlands	-112,5%
Poland	0,8%
Portugal	-21,3%
Romania	6,4%
Slovakia	44,0%
Slovenia	33,2%
Spain	31,3%
Sweden	41,5%
United Kingdom	-10,8%

Appendix VI – Adjusted national distance from Kyoto target

The ETS sectors' contribution to Kyoto is fixed, as it corresponds to the ETS cap, regardless of the emissions they will effectively produce. Thus, any deviation from the ETS cap cannot be taken into account to calculate the national distance from the Kyoto target.[23] In order to understand how far Member States effectively are from their Kyoto target, we have to adjust the national emissions gap from Kyoto by subtracting the ETS deficit of permits (ETS emissions above the cap have to be reduced by the ETS sectors and it represents a private cost) and by adding any surplus of permits (ETS emissions below the cap generate a surplus of allowances which is a private asset and does not reduce the distance from the Kyoto target). This adjusted national target corresponds to the emissions reduction burden imposed on the non-ETS sectors.

23 For the ETS sectors, any emission above their cap represents a private cost, while any emission reduction below the cap generates a surplus of allowances. This surplus is a private asset that firms can capitalize by selling permits within the ETS while it has no value at a national level

Table 15

Aggregate, ETS and non-ETS distance from their respective targets (Mton)

	ETS Verified emissions 2010	ETS Cap	ETS Distance From target	National emissions 2010	Kyoto target	National Distance From target	Non-ETS emission 2010	Non-ETS target	Non-ETS Distance From target
Austria	31,0	30,7	-0,3	84,4	68,0	-16,4	53,4	37,3	-16,1
Belgium	50,1	58,5	8,4	132,2	132,6	0,4	82,1	74,1	-8,0
Denmark	25,3	24,5	-0,8	61,4	53,7	-7,7	36,1	29,2	-6,9
Finland	41,3	37,6	-3,7	74,4	70,4	-4,0	33,1	32,8	-0,3
France	114,7	132,8	18,1	524,6	562,9	38,3	409,9	430,1	20,2
Germany	454,7	453,1	-1,6	960,1	985,8	25,7	505,4	532,7	27,4
Greece	59,9	69,1	9,2	120,3	130,5	10,2	60,4	61,4	1,0
Ireland	17,4	22,3	4,9	60,6	61,9	1,3	43,2	39,6	-3,6
Italy	191,5	201,6	10,1	493,6	485,4	-8,2	302,1	283,8	-18,3
Luxembourg	2,3	2,5	0,2	12,2	9,2	-3,0	9,9	6,7	-3,2
Netherlands	84,4	87,5	3,1	210,7	199,1	-11,6	126,3	111,6	-14,6
Portugal	24,2	34,8	10,6	74,8	54,7	-20,1	50,6	19,9	-30,8
Spain	121,5	152,3	30,8	353,9	325,6	-28,3	232,4	173,3	-59,1
Sweden	22,7	22,8	0,1	64,4	75,4	11,0	41,7	52,6	10,9
United Kingdom	237,4	246,2	8,8	584,5	679,1	94,6	347,1	432,9	85,8
EU-15	1478,3	1576	98,0	3812,1	3894,4	82,3	2333,8	2318,1	-15,7

Table 16

EU15 ETS distance from targets and costs (Mton)

	2008	2009	2010	Total 2nd period (2008-2010)
Allocated cap	1.576	1.576	1.576	4.729
Verified emissions	1.622	1.436	1.478	4.536
ETS distance from target	46	-140	-98	-193
Average EUAs price	22,3	13,2	14,3	
ETS costs (M€)	1.021	-1.848	-1.407	-2.234

Table 17

EU15 non-ETS distance from targets and costs (Mton)

	2008	2009	2010	Total 2nd period (2008-2010)
Non-ETS target	2.318	2.318	2.318	6.954
Verified emissions	2.376	2.288	2.334	6.997
Non-ETS distance from target	58	-31	16	43
Average EUAs price	22,3	13,2	14,3	
Non-ETS costs (M€)	1.295	-403	225	1.117

Appendix VII - theoretical CO_2 coal-to-gas switch price

Before a price is attached to the carbon emissions, generating power through coal plants is on average cheaper than using gas, causing an increase of emissions since coal is more carbon intensive than gas. After the ETS was established and carbon emissions have been priced, burning coal becomes relatively more expensive than burning gas. Depending on the gas, coal and carbon prices, power companies and the central dispatcher will evaluate if coal plants are still more convenient than gas plants.

Based on the historical prices of coal and gas weighted by the plants' thermal efficiencies and by the fuels' CO_2 emissions factors, it is possible to calculate the theoretical CO_2 price that would make the generation of electricity through the burning of gas or coal equally preferable.

The theoretical CO_2 coal-to-gas switch price has been calculated using the day ahead price of National Balancing Point (NBP) gas traded in the British exchange market in pence per therm and the prices of the first month contract CIF ARA coal traded in dollars per ton. The cost of producing electricity by burning either gas or coal has been calculated assuming that coal plants have a 38 per cent thermal efficiency while the CCGT gas plants have a 53 per cent thermal efficiency. In addition to the fuel marginal costs, the cost of producing electricity is increased by the price of the CO_2, which has to be weighted with the coal and gas fuels emission factors for different power generation technologies, assuming that burning coal produces 950 kg CO_2 per MWh of electricity generated, while burning gas produces 450 kg CO_2 per MWh of electricity generated.

Coal plant:

electricity price (€/MWh) = coal price (€/MWh) / 38% + CO2 price (€/ton CO2) * 0.95 (ton CO2/MWh)

Combined cycle turbine gas plant:

electricity price (€/MWh) = gas price (€/MWh) / 53% + CO2 price (€/ton CO2) * 0.45 (ton CO2/MWh)

Given the gas price and the coal price, by equating the electricity prices we can assess the theoretical price of CO_2 which would make generating power by burning gas or burning coal an equally preferable process.

The theoretical CO_2 price has been calculated on the basis of gas, coal and carbon average weekly prices from 2005 to 2011.

Table 18

Yearly average prices of carbon, gas, EUAs and switch price (€)

Year	Coal price		Gas price		EUA price (€)	Switch price	
	€	Δ%	€	Δ%	€	€	Δ%
2005	5,5		23,8		18,30	36,6	
2006	5,8	7%	20,7	-13%	17,30	29,7	-19%
2007	7,3	25%	14,7	-29%	0,65	14,7	-50%
2008	11,6	59%	24,9	70%	22,30	27,7	88%
2009	5,9	-49%	11,4	-54%	13,20	10,8	-61%
2010	8,1	37%	16,9	49%	14,30	17,6	63%
2011	10,3	27%	22,0	30%	14,60	23,4	32%

Source: own elaboration on Pointcarbon and Bluenext (carbon price), Platts (coal price), World Gas Intelligence and APX Endex (gas price)

By observing the fuels' average yearly price we can observe that between 2005 and 2006 the carbon price increased (+7%) and the gas price decreased (-13%) causing the reduction of the switch price (-19%), a trend confirmed also in 2007. On the contrary in 2008 the rise of coal price (+59%) was counterbalanced by a stronger growth of gas price (+70%) thus increasing the switch price. In 2009 the economic downturn cut the gas price (-54%) more than the coal price (-49%) decreasing the switch price (-61%). Finally in 2010 and in 2011 the economic rebound pushed the gas price at an higher rate than coal price causing a net increase of switch price.

Appendix VIII - Carbon tax experiences in Europe and EC proposal

Several countries have already opted for a carbon tax, thus its effects are quite well understood. Nordic countries have first adopted this instrument in the 1990s and today they are characterized by high tax rates. Later, other countries introduced a carbon tax mainly in the transport sector, and recently many European member states are considering a carbon tax to abate the emissions in non-ETS sectors. Some carbon tax programs return the revenues through income tax reductions or reducing tax burdens on employers (UK, Ireland), other earmark the revenues to government budgets (Finland, Norway, Sweden, Denmark), other to R&D or to climate mitigation programs (Netherlands).

In general, it is preferable to introduce the tax with "revenue-neutral" mechanisms that encourage consumers to change their behavior while reducing other taxes, without

Table 19

Carbon tax in Europe – comparison between different countries

Country	Year of implementation	Level of tax (€ 2009/ton co2)	Annual revenue (M€)	Application	Revenue distribution
Finland	1990	20€/ton CO2	500	Fossil fuels for transport and heating	Government budget; accompanied by independent cuts in income taxes
Netherlands	1990	12€/ton CO2 + energy taxes	3.200	Fossil fuels and electricity Exemptions for sectors of high energy intensity and gas for electricity production	Reductions in other taxes; climate mitigation programs
Norway	1991	34,4 €/ton CO2	600	Fossil fuels Exemptions for heavy industry and international transports	Government budget; R&D
Sweden	1991	108 €/ton CO2	2.443	Fossil fuels Partial exemptions for industry and agriculture	Government budget; R&D; Lowering of social charges on employers
Denmark	1992	13,43 €/ton CO2	600	Fossil fuels Exemptions for energy-intensive activities and electricity production	Environmental subsidies and returned to industry
United Kingdom	2001	GPL 5,49 Oil 7,73 Gas 13,09 Mixed carbon-energy tax	800	Fossil fuels and electricity Does not concern household	Reduction in other taxes and environmental subsidies
Ireland	2009	15 €/ton	280	Fossil fuels Exemptions for no energy-use and ETS sectors	Lowering of social charges on employers

Sources: own elaboration on Ombeline Gras "L'introduction d'une taxe carbone et ses effets sur la compétitivité en France, internship report" OFCE, September 2009 and J. Sumner L. Bird H. Smith "Carbon taxes: a review of experiences and policy design consideration" NREL, December 2009.

raising money for government general funds or emission reduction programs. Furthermore, in addiction to environmental benefits, lowering income taxes could foster new employment opportunities (OECD 2001).

In June 2011 the European Commission issued a proposal of Directive (COM 2011 169/3) aimed at restructuring the Community framework for the taxation of energy products and electricity, harmonizing the different national tax systems among the EU27 Member States. The proposal is in line with the climate policies and objectives of the EU Climate and Energy Package adopted in 2009. The aim is to price emissions in those sectors not included in EU-ETS. The tax should apply to the consumption of motor fuels, heating fuels and electricity.

The most innovative part of the European proposal is to separate the tax rate into energy and carbon components. In particular, the tax applies to the fuel's energy content (€/GJ) and it varies according to the different kinds of fuel (energy component); on top of that, for any kind of fuel, a tax of EU20 is applied to any produced carbon emission. The proposal sets a minimum tax rate for 2013 that gradually increases to 2018 when all the tax rates will be aligned among European economies.

Table 20

Minimum levels of taxation applicable from 1 January 2013 to motor fuels

		CO2 -related taxation	General energy consumption tax		
		1st January 2013	1st January 2013	1st January 2015	1st January 2018
Motor fuels					
	Petrol	20 €/tonCO2	9,6 €/GJ	9,6 €/GJ	9,6 €/GJ
	Gas oil		8,2 €/GJ	8,8 €/GJ	
	Kerosene		8,6 €/GJ	9,2 €/GJ	
	LPG		1,5 €/GJ	5,5 €/GJ	
	Natural gas		1,5 €/GJ	5,5 €/GJ	
Heating fuels			0,15 €/GJ		
	Gas oil				
	Heavy fuel oil				
	Kerosene				
	LPG				
	Natural gas				
	Coal & coke				
Electricity	Electricity	-			

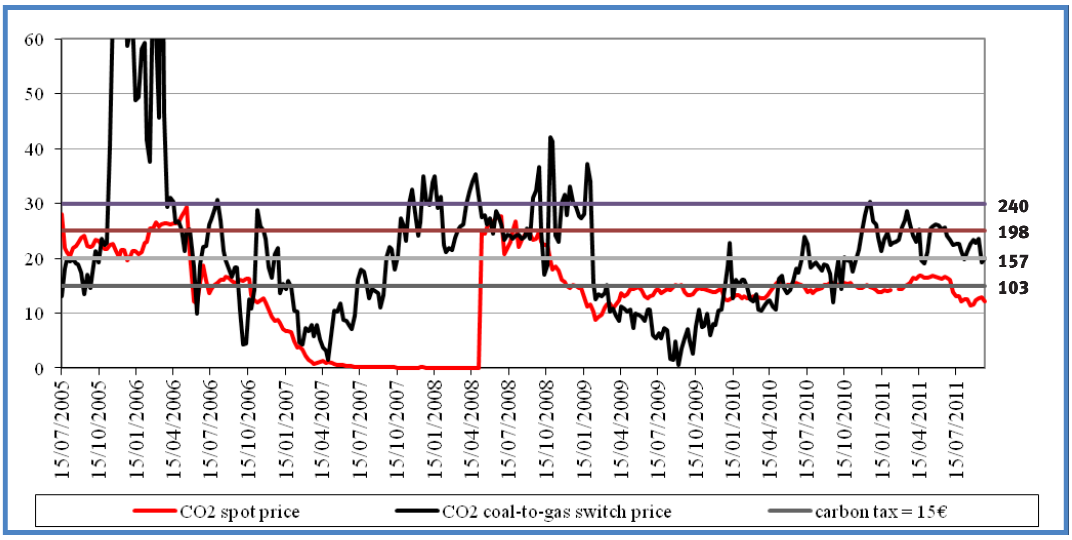
Sources: EC proposal COM 2011 169/3

Appendix IX – Carbon Tax and emissions reduction via fuel switching

Figure 12 compares the carbon switch price with different levels of a carbon tax. This analysis clarifies the number of weeks where the carbon tax would have been higher than the carbon switch price, favouring a switch from coal to gas.

FIGURE 12

Number of switching weeks (Theoretical switch price < carbon tax)



Sources: own elaboration on Bluenext, Platts, ICE data

Table 21 reports the gas plants' power capacity and it compares their historical power generation with the maximum amount of electricity the gas plants would have produced if they were running at the best of their capabilities. This difference constitutes a technical constraint: the maximum amount of electricity produced by coal plants that can be replaces by gas plants. We call this variable the "*gas plants' residual gross power generation capability*".

TABLE 21

Gas plants' capacity generation, historical and maximum power generation

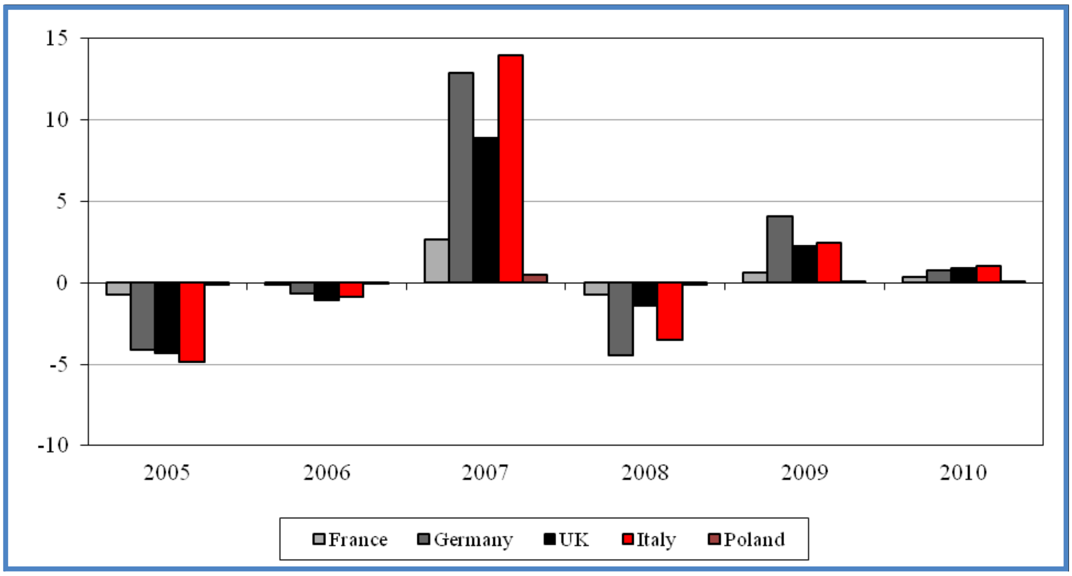
	France		Germany		UK		Italy		Poland	
	2005-2007	2008-2010	2005-2007	2008-2010	2005-2007	2008-2010	2005-2007	2008-2010	2005-2007	2008-2010
capacity generation (MW)	5.605	6.123	20.376	26.051	32.978	34.291	39.789	47.261	1.291	1.236
Historical Power generation GWh)	25.760	24.403	83.000	100.619	154.713	169.773	165.887	168.867	6.163	5.758
Maximum power generation (GWh)	33.071	36.126	120.218	153.703	194.570	202.319	234.755	278.840	7.617	7.290
residual power generation capability (GWh)	7.311	11.722	37.218	53.084	39.857	32.546	68.868	109.973	1.454	1.532

Sources: own elaboration on DG Energy "EU energy trends to 2030 - update 2009", DG Energy "Countries factsheet", Pointcarbon, Platts and ICE data

The figures below show in greater detail the emissions reduction induced through different rates of carbon tax at a country level. Emissions in Italy, Germany and UK would have been reduced greatly in the event of the introduction of a carbon tax, especially during 2007, 2009 and 2010. The opportunity to further reduce emissions via fuel switching would be lower in France and Poland because of their gas plants' scarcity and constraints.

FIGURE 13

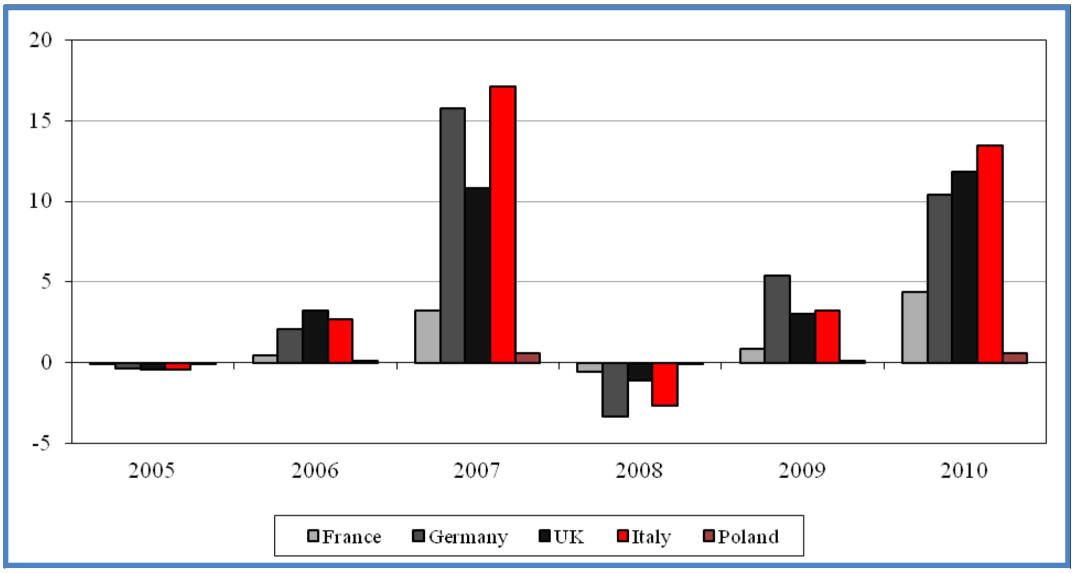
Emissions reduction from fuel switching with a 15€/ton carbon tax (Mton)



Sources: own elaboration on DG Energy "EU energy trends to 2030 - update 2009", DG Energy "Countries factsheet", Pointcarbon, Platts and ICE data

FIGURE 14

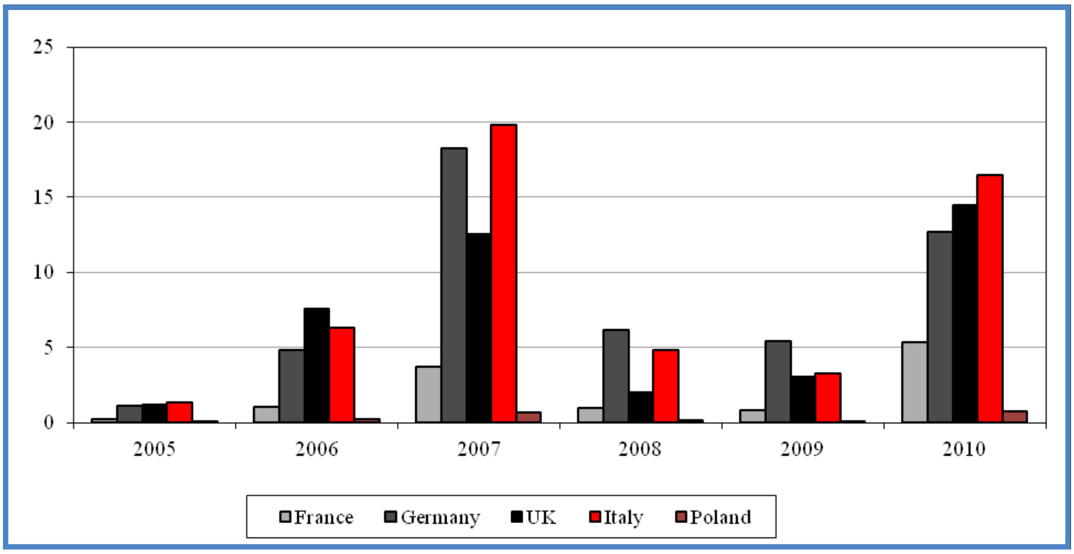
Emissions reduction from fuel switching with a 20€/ton carbon tax (Mton)



Sources: own elaboration on DG Energy "EU energy trends to 2030 - update 2009", DG Energy "Countries factsheet", Pointcarbon, Platts and ICE data

FIGURE 15

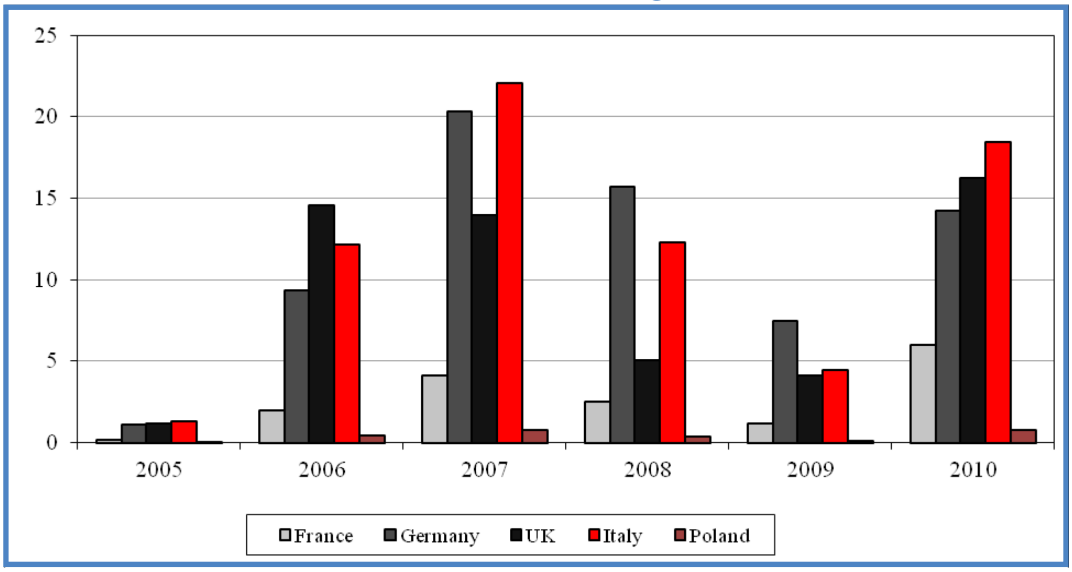
Emissions reduction from fuel switching with a 25€/ton carbon tax (Mton)



Sources: own elaboration on DG Energy "EU energy trends to 2030 - update 2009", DG Energy "Countries factsheet", Pointcarbon, Platts and ICE data

FIGURE 16

Emissions reduction from fuel switching with a 25€/ton carbon tax (Mton)



Sources: own elaboration on DG Energy "EU energy trends to 2030 - update 2009", DG Energy "Countries factsheet", Pointcarbon, Platts and ICE data

IBL **Special Report**

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Cosa Vogliamo

La nostra filosofia è conosciuta sotto molte etichette: "liberale", "liberista", "individualista", "libertaria". I nomi non contano. Ciò che importa è che a orientare la nostra azione è la fedeltà a quello che Lord Acton ha definito "il fine politico supremo": la libertà individuale. In un'epoca nella quale i nemici della libertà sembrano acquistare nuovo vigore, l'IBL vuole promuovere le ragioni della libertà attraverso studi e ricerche puntuali e rigorosi, ma al contempo scevri da ogni tecnicismo.

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