# Cap and Invest: The Economic Benefits of Investing EU ETS Auction Revenues into Energy Savings

*Summary and key findings of a modelling study commissioned by RAP, and conducted by Cambridge Econometrics (CE) and Energy Research Centre of the Netherlands (ECN).*[1, 2]

## Key Finding

Across Europe there is an increasing concern over rising energy prices and their impacts on industry, households, and national economies. Many people seem to believe that relaxing Europe's commitment to a clean energy future is the only way to reduce energy costs. This study demonstrates that there is a better path: by focusing on the *smart use of carbon revenues*, instead of merely hoping to drive change through *carbon prices*, Europe can meet ambitious clean energy goals at lower costs to families, businesses, and national economies.

This study shows that energy efficiency programmes can save several times more carbon per consumer Euro spent than would just raising carbon prices through the Emissions Trading Scheme (ETS). It also finds that a combined strategy of a tighter cap along with targeted energy efficiency programmes can deepen carbon savings towards 2030 goals with minimal or neutral effects on power bills and the economy more generally. This is provided, however, that the ambition levels of the ETS cap and energy efficiency strategies or programmes are sufficiently stringent, relatively evenly matched in order to be complementary, and, very importantly, enforceable. Both the ETS cap and the contribution of energy efficiency to meeting this cap would need to be reviewed periodically.

## Motivation for the Study

The power sector is the largest single source of industrial carbon emissions in the EU and is crucial to the well-being of nearly all businesses and households. The nearly-complete decarbonisation of the European power grid and the simultaneous electrification of the transportation and buildings sectors are essential to meeting Europe's carbon reduction goals between now and 2050.[3] It is therefore crucial to understand and effectively manage the intersection of the ETS with power sector programmes and markets.

The ETS has been a central pillar of the 2020 Climate and Energy Package. The review of this package for 2030, involves debate about the role of the ETS and the extent to which it should be or should not be supported by complementary policies. Carbon-pricing advocates sometimes object that other public

[1] Sijm, J.P.M., Boonekamp, P.G.M., Summerton, P., Pollitt, H., & Billington, S. (2013). *Investing EU ETS Auction Revenues into Energy Savings* (ECN-E-13-033). Petten, Netherlands: Energy Research Centre of the Netherlands. Retrieved from http://www.ecn.nl/docs/library/report/2013/e13033.pdf.

[2] For further information about the study and policy implications contact: Sarah Keay-Bright at skeaybright@raponline.org or Edith Bayer at ebayer@raponline.org.

[3] See the 2050 Roadmap of the European Climate Foundation at http://www.roadmap2050.eu/ and the European Commission's 2050 Energy Roadmap at http://ec.europa.eu/energy/energy2020/roadmap/index_en.htm.

policies are interfering with carbon markets or undermining the carbon price. The context underpinning the current review is, however, very different compared with five years ago when the 2020 package was originally adopted. At present, politicians are gravely concerned about:

- Cost of policies to the state; and
- Impact of policies on:
    a. Competitiveness of energy-intensive industry;
    b. Competitiveness of incumbent energy providers; and
    c. Affordability of energy bills for residential consumers, including the most vulnerable—those classified as "energy/fuel poor."

The ETS now enters a phase where Member States will receive revenues from the auctioning of EU allowances (EUA—i.e. one tonne of $CO_2$). The receipt of revenues provides an opportunity for Member States to fund or finance the costs of decarbonisation policy measures. A well-designed policy package would have the following characteristics:

1. Achieve decarbonisation and environmental objectives at least cost to the public purse;
2. Minimise negative impacts or increase positive impacts on the economy (in particular vis-a-vis a, b, and c listed above); and
3. Benefit society more broadly.

Studying these goals, it is important to consider especially how carbon prices affect power prices in competitive wholesale power markets—the type of power markets now embedded in the EU's "target model" for the power sector. In such markets, high carbon prices tend to transfer wealth from consumers to power generators. This is because carbon prices drive up clearing prices in power markets, and the cost to consumers across the whole market is usually much larger than the cost to generators who are paying for carbon allowances. These higher clearing prices confer windfall gains on many generators. This in turn leads to higher consumer power bills and negative macro- and socio-economic effects.

But there is a solution. Energy efficiency has the opposite effect—delivering savings to consumers while lowering clearing prices across the entire wholesale power market. Utilities will experience reduced revenues (and lower costs) due to lower electricity sales, and all participants will see lower clearing prices in wholesale electricity markets due to lower demand generally. Consumers that invest in end-use efficiency will see lower bills, while all consumers benefit from lower power prices. Together, these effects can deliver large, positive macro- and socio-economic impacts.

Combining a tighter cap with energy efficiency investment through programmes results in the cancelling out, at least partially, of these opposing wealth flows between utilities and consumers. As energy efficiency lowers the carbon price and power clearing price, space is created to tighten carbon caps. Energy efficiency is triply valuable as it:

- Reduces bills directly;
- Lowers power market clearing prices, and further lowers consumer bills indirectly; and
- Lowers carbon prices, which again further lowers bills indirectly.

Auction revenues can directly link the EU Emissions Trading Scheme (ETS) to the needed complementary energy efficiency investments. Adjustment mechanisms, such as set-asides, or price floors could be used to maintain a minimum carbon (EUA) price and thus guarantee a stable revenue stream to fund energy efficiency programmes.

## Commissioning the Study

RAP commissioned Cambridge Econometrics (CE) and Energy Research Centre of the Netherlands (ECN) to explore the interaction of energy efficiency investments with the carbon price and the resulting emissions reductions and macro-economic and societal impacts. The study involved modelling three core scenarios within a 2020 timeframe applied across the EU27: [4]

1. Tightening the ETS cap from 21 percent to 34 percent by 2020 relative to 2005;
2. Introducing an Energy Efficiency Obligation (EEO) of 1 percent p.a. for energy suppliers/distributors to 2020; and
3. Combination of 1 and 2 above.

Other scenarios were explored, including further investment to unlock the full energy efficiency potential possible by 2020 for scenarios 1, 2, and 3 above, as well as the impact of setting aside EUAs.

The modelling for this study was carried out assuming a relatively high carbon price (a baseline carbon price of 17 EUR/t$CO_2$) which in 2013 would be considered very high. How tight the ETS cap should be or how high the carbon price should be between now and 2030 is currently being debated. Because this study serves to show the dynamic interactions among energy efficiency investment, the ETS, and the wider economy, the level of the baseline carbon price used in the study does not affect its ultimate conclusions. While the timeframe for the various scenarios assessed was to 2020, the analyses of these interactions are still relevant at all timescales, including to 2030.

Critical to understanding the results of the study is a basic understanding of the “merit order” dispatch used in power systems, power clearing prices, and infra-marginal rent. These important concepts are explained in Box 1.[5]

[4] Using the Energy-Environment-Economy Model for Europe (E3ME).

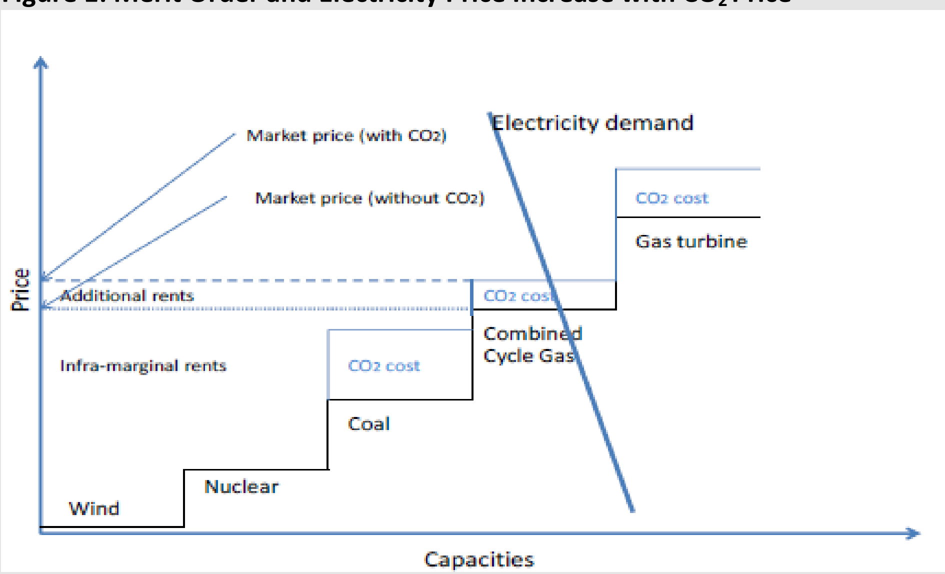
[5] The interaction of the carbon price with power prices in wholesale electricity markets and the role of complementary policies, including investment of carbon revenues, are explained in more detail in the following papers: Cowart, R. (2012). *Prices and Policies: Carbon Caps and Efficiency Programmes for Europe’s Low-Carbon Future.* European Council for an Energy Efficient Economy: Summer Study Proceedings No. 2-432; and Cowart, R. (2008). Carbon Caps and Efficiency Resources: How Climate Legislation Can Mobilize Efficiency and Lower the Cost of Greenhouse Gas Emission Reduction. *Vermont Law Review,* Vol. 33 No. 2.

## Box 1: Merit Order, Power Clearing Prices, and Infra-Marginal Rent

In liberalised electricity markets, as in Europe, electricity prices are no longer set by regulators on the basis of approved costs and an approved rate of return on investment; they are determined by the market. The market operator stacks up the competitive bids to supply energy, starting with the cheapest first, until the total supply stack meets demand for that moment in time. The stacking of price bids from cheapest to most expensive is the "merit order" and very often, though not always, tracks the underlying variable cost (per MWh) of the bidding resources. Such a cost-based merit order is illustrated in Figure 1 for a typical thermal-based system.

As in any commodity market the most expensive bid to "clear the market" (i.e., to find a willing buyer) sets the "clearing price," and this price is paid to all suppliers of energy needed to meet demand for that particular interval. In Figure 1, the vertical line slanting to the left represents electricity demand at a certain moment in time and shows how demand is slightly responsive to price, as less capacity is required to meet demand at higher prices. The clearing price is the point on the vertical (y) axis where the electricity demand curve (line) crosses the capacity curve (i.e. the steps in Figure 1). For the case illustrated in Figure 1, the combined cycle gas plant sets the clearing price and this price is paid to all generators that have cleared the market to meet demand (i.e. wind,[6] nuclear, coal, and some combined cycle gas). When a carbon price is applied and where the marginal plant is fossil-fuelled, the clearing price increases and all generators in the stack receive additional rent.

**Figure 1: Merit Order and Electricity Price Increase with $CO_2$ Price[7]**




Keppler and Cruciani (2010; as reported in IEA 2011[8]) have estimated that this carbon-price rent, or windfall profit, amounted to more than EUR 19 billion for the first phase of the EU ETS. Although auctioning of EUAs takes place from 2013 and government will now receive revenues, the phenomenon of additional rents due to the carbon price will continue as before. Whenever a fossil unit is on the margin, (which in Europe occurs most hours of the year), any resource receiving market-based prices will receive added revenue from the carbon-influenced clearing price. For low carbon generation, including nuclear power at any time, and gas-fired power when coal is on the margin, the added revenue exceeds added costs, and the carbon price delivers increased profits. Even fossil units benefit from this effect as the higher clearing price will pay back the cost of allowances, even for coal plants to some extent. For example, when gas is on the margin, the higher clearing prices will pay back the cost of allowances for a gas plant, but coal generators will get back about half of their carbon costs.

[6] Except where out-of-market prices are used, as when wind generators are paid a fixed price through a feed-in tariff.
[7] Philibert, C. (2011). *Interactions of Policies for Renewable Energy and Climate*. Paris, France: International Energy Agency. Retrieved from http://www.iea.org/publications/freepublications/publication/interactions_policies.pdf.
[8] Philibert, 2011.

## Why the Cost Paid by Consumers per tonne of $CO_2$ Reduced can be Much Greater than the Carbon Price Would Suggest

Analysis in this study, as in similar studies across Europe and North America, reveals that, when carbon prices are simply added to competitive power markets without additional measures taken, consumers will pay much more for carbon reduction than the cost of allowances would suggest.

The extra infra-marginal rent paid to generators, due to the carbon price raising the wholesale electricity price (see Box 1), passes through to consumer bills. This study shows that the resulting power bill increase gives rise to a cost per tonne $CO_2$ reduced that is much higher than the carbon price. Essentially, consumers are paying for the extra profit that the carbon price gives to many generators.

## There is a Solution: Investing in Energy Efficiency

To curb carbon pollution and soften the impacts of climate change, many tools are required. There is wide agreement in European policy circles, supported by this study, that carbon prices are an important foundation policy to drive carbon reductions. But, in competitive power markets, additional complementary measures are needed to spur investments in renewable energy and to moderate the cost impacts of carbon prices on businesses and families.

End-use energy efficiency is the key consumer-friendly policy to lower the cost impacts of carbon reductions in power markets. If efficiency investments are stepped up as carbon prices are introduced, costs are reduced in three ways:[9]

- First, efficiency programmes bring down the clearing price across the entire market because lower total demand for energy would move the vertical electricity demand curve in Figure 1 to the left such that it will intersect lower down the supply curve. This lowers the clearing price for power across many hours of the year.
- Second, by lowering demand for power, energy efficiency also lowers demand for carbon allowances, consequently lowering the carbon price. A lower carbon price would reduce the height of the "$CO_2$ cost" blocks in Figure 1 and, where the marginal plant is fossil-fuelled, would further lower power clearing prices. Thus, electrical end-use efficiency lowers both the cost of

[9] A reduction in the demand for electricity will also decrease the demand for fossil fuels, which would lead to lower wholesale fossil fuel prices. Reduced demand for electricity also requires less infrastructure for the generation, transmission, and distribution of electricity. These factors, among others, reduce system costs that should result in lower power prices, lower transmission and distribution tariffs, and ultimately lower electricity bills for consumers. RAP analysis shows that the value of avoided energy use is substantially greater than the direct value of the energy savings (by a factor of five) if other categories of resource savings are counted (including loss avoidance, lower reserve requirements, and other resource and environmental benefits). See: Cowart, R. & Neme, C. (2012, January). *Energy Efficiency: Power Markets, System Benefits and Key Design Issues*. Presented at the meeting of the Energy Savings Coalition, Brussels. Retrieved from http://www.raponline.org/EVent/rap-presents-at-energy-efficiency-workshop-in-brussels-power-markets-system-benefits-design; and Lazar, J. & Colburn, K. (2013). *Recognizing the Full Value of Energy Efficiency*. Montpelier, VT: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6739.

power to European industry, and lowers the cost of carbon allowances to all ETS-covered businesses, including those outside the power sector.

- Finally, cost-effective end-use efficiency lowers energy bills for the households and businesses that install efficiency improvements, lowering their total bills, as well as the price of power.

In summary, energy efficiency and the ETS transfer costs and savings between utilities and consumers in opposite directions. Implemented jointly, these effects s can offset each other; the extent to which this happens depends on the relative strength or effect of the ETS and energy efficiency programmes.

## What Happens When you Tighten the ETS Cap?

One of the three core scenarios of this study explored tightening the ETS cap from 21 percent to 34 percent by 2020 relative to 2005. This results in the following:

- Lower fossil fuel use in the ETS sectors (including both industry and power generation);
- Increase in the carbon price paid by generators from €17 to €80 per tonne $CO_{2;}$
- Average increase in the total power bill for electricity consumers of €487 per tonne $CO_2$ reduced in the power sector;
- A high carbon price and therefore:
  - High EUA auction revenues (which, for this scenario, are assumed not to be recycled into carbon abatement in the power sector);
  - Slightly lower power demand by electricity end-users (as consumers are not very responsive to prices) but this reduction in demand is not enough to prevent a higher power clearing price resulting from a higher carbon price and this leads to:[10]
    - Greater infra-marginal rent/profit for many generators;
    - Higher household electricity bills;
    - Lower real incomes;
    - Less consumer spending;
    - Reduced industrial competitiveness;
    - Less employment; and
    - Lower GDP.

## What Happens When you Introduce an Energy Efficiency Obligation (EEO)?[11]

Compared to a tighter cap, an EEO has a much greater impact on reducing power use. Emissions in the power sector, however, are comparatively higher as the lower carbon price results in a more carbon intensive power mix (though this is dependent on assumptions about wholesale gas and oil prices).

[10] See tables 6 and 7 of Sijm et al., 2013.
[11] The analysis was undertaken before adoption of the Energy Efficiency Directive.

Reduced power use directly reduces power bills, but it also results in a lower carbon price and a lower power clearing price, leading to:[12]

- Less infra-marginal rent for generators;
- Lower household electricity bills;
- Decrease in the carbon price paid by generators from €17 to €9 per tonne $CO_2$;
- Average benefit, not cost, in terms of lower power bills of €754 per tonne $CO_2$ reduction in the power sector;
- Higher real incomes;
- More consumer spending;
- Greater industrial competitiveness;
- More employment; and
- Higher GDP.

Additional modelling runs were carried out involving energy efficiency investment in the ETS sector (using ETS auction revenues) under different conditions. These runs reinforce the findings set out above for the case of an EEO.

## What Happens When you Combine a Tighter ETS Cap and Energy Efficiency Investment?

When energy efficiency investment, through an EEO, is combined with a tighter carbon cap (of 34 percent by 2020), very significant greenhouse gas emissions reductions can be achieved with minimal or neutral impact on household power bills and the economy more broadly. This is largely because the wealth transfer from consumers to utilities due to a higher carbon price is offset by the wealth transfer from utilities to consumers through energy efficiency. Compared with reducing the ETS cap only, this modelling run resulted in:[13]

- Greater greenhouse gas and $CO_2$ emissions reductions as emissions reductions from both approaches are combined;
- Moderated carbon price, resulting in:
    - Some revenues for the Member State;
    - Neutral impact on the power clearing price as energy efficiency mitigates the increase resulting from a higher carbon price;
    - Reduced increase in the average household bills through both lower power prices and lower electricity use; and
    - Relatively neutral macro- and socio-economic impacts.

## Is a Zero or Low Carbon Price a Bad Thing?

While a high carbon price can have a disproportionate and negative effect on consumer bills, a zero or very low carbon price provides no incentive for investment in carbon reduction and also means no or low EUA auction revenues needed for governments to support energy efficiency programmes. It is

[12] See tables 6 and 7 of Sijm et al., 2013.
[13] See tables 6 and 7 of Sijm et al., 2013.

therefore necessary to apply an adjustment mechanism, such as setting aside a certain amount of emission allowances or applying a minimum price (e.g., price floor). This study shows[14] how the effects of carbon pricing on energy savings and $CO_2$ emissions reduction are substantially enhanced if the resulting decline in the ETS carbon price—due to the additional energy efficiency investments—is nullified by setting aside a certain amount of emission allowances. As a result, revenues will continue to be available for further investment in energy efficiency.

## Conclusions

- Carbon pricing is an important tool to guide power markets and investments; carbon pricing alone, however, will not deliver the greenhouse gas reductions needed in the power sector—certainly not at least cost or at an acceptable cost to society. There is a limit to the incremental benefit achieved by raising the carbon price to overcome barriers to investment in energy efficiency and low-carbon technologies. Evidence shows that market barriers, especially to energy efficiency, are too great to be addressed through prices alone such that programmes or regulations are needed to unlock this potential.
- Wholesale power markets can multiply the cost of carbon prices to consumers, and confer windfall gains in the form of transfer payments on many generators. These transfer payments do little to reduce emissions, will tend to undercut societally efficient carbon reductions, and will divert limited societal resources away from the investments needed to overcome barriers to low-cost efficiency and to advance low-carbon generation technologies.
- As the carbon price increases, so do consumers' power bills and the magnitude of negative macro- and socio-economic impacts. Energy efficiency has the opposite effect. Combining a tighter cap with energy efficiency investment through programmes results in the cancelling out, at least partially, of these opposing wealth flows between utilities and consumers.
- As energy efficiency lowers the carbon price and power clearing price, space is created to tighten carbon caps. A combined strategy adds together the emissions reductions of both approaches with minimal or neutral effects on power bills and the economy more generally. This combination will cost-efficiently accelerate progress towards the long-term objective of lowering greenhouse gas emissions in line with Europe's 2050 goals.
- However, the ambition levels of the ETS and energy efficiency strategy will need to be sufficiently stringent, relatively evenly matched to be complementary, and, importantly, enforceable. This suggests that the EU regulatory framework for energy efficiency needs to be considerably strengthened if it is to effectively counter and complement the highly regulated ETS in order to adequately protect consumers. Both the ETS cap and the contribution of energy efficiency to meeting this cap would need to be reviewed periodically.
- Auction revenues can directly link the EU Emissions Trading Scheme (ETS) to the needed complementary energy efficiency investments. Additional tools such as adjustment mechanisms, set-asides, or price floors could be used to maintain a minimum carbon (EUA) price and thus guarantee a stable revenue stream to fund energy efficiency programmes.

[14] See Figure 5 in Sijm et al., 2013.