Energy solutions for a changing world

Carbon Caps and Efficiency Resources: Launching a "Virtuous Circle" for Europe

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1 Cowart, R. (2011). *Prices and Policies: Carbon Caps and Efficiency Programmes for Europe's Low-Carbon Future.* Montpelier, VT: The Regulatory Assistance Project. ECEEE 2012 Summer Study Proceedings No. 2-432.

2 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.

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Acronyms

CE Cambridge Econometrics
CO_2 Carbon Dioxide
ECN Energy Center of the Netherlands
EEO Energy Efficiency Obligation
ETS Emissions Trading Scheme
EUA EU Emission Allowance Units
EU European Union
E3ME Energy-Environment-Economy Model for Europe
GDP Gross Domestic Product
GHG Greenhouse Gas
IEA International Energy Agency
KWh Kilowatt Hour
MAC Marginal Abatement Cost
MWh Megawatt Hour
RAP Regulatory Assistance Project
RGGI Regional Greenhouse Gas Initiative
tCO_2 Tonne of CO_2

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Executive Summary

The EU ETS is an important tool to guide power markets and investments by larger users of fossil energy; carbon pricing alone, however, will not deliver the GHG reductions needed in the energy sector – certainly not at least cost nor at an acceptable cost to society. There is a limit to the incremental benefit achieved by raising the carbon price to overcome the barriers that block investment in energy efficiency and low-carbon technologies. Evidence shows that well-known market barriers, especially to energy efficiency for smaller users of energy, are rarely addressed through prices alone; well designed and properly implemented programmes and regulations are needed to unlock the potential multiple benefits of energy efficiency. Indeed, expert authorities such as the International Energy Agency (IEA) are promoting use of cost effective energy efficiency and technology policies to improve the short- and long-term efficiency of carbon pricing.

Power markets magnify the consumer cost of carbon prices

With respect to emissions from electric generation in particular, a further complication arises from [what is known as] the "merit order effect" in wholesale power markets. This can multiply the cost of carbon prices to consumers, and confer windfall profits in the form of transfer payments to many generators. Modelling conducted by Cambridge Econometrics (CE) and the Energy Centre of the Netherlands (ECN)[3], commissioned by RAP, shows that when a carbon price[4] is imposed in European power markets, the final cost to consumers per tonne of carbon reduced can be several times greater than the carbon price per tonne paid by fossil generators and others in the carbon market. This result has been modelled in North American power markets and was found across a variety of scenarios in the CE-ECN study for Europe. For example, a scenario involving tightening of the GHG cap by 30 percent would raise the carbon price from 16.5 to 80 euro per tonne of CO_2 (tCO_2) but the cost that consumers would pay in power bills would amount to 478 euro/tCO_2 actually reduced due to the carbon price – roughly six times higher than the cost of carbon in the carbon market.

Energy efficiency investments allow greater carbon reductions at lower cost to consumers and the economy

Using the same data, the CE-ECN study then considered the impact of greater investments in end-use energy efficiency, in line with the Energy Efficiency Obligations in place in several nations and many US states. Adjusting the scenario above, CE-ECN found that if the tighter cap were combined with an energy efficiency obligation of 1 percent p.a., then the consumer cost would drop to 162 euro/tCO_2 reduced, along with an extra 20 percent in carbon emissions reductions.

The modelling performed in this study also examined macro-economic impacts on the European economy. Since the ETS can have a significant impact on power prices and total power bills, this can in turn lead to important impacts on disposable income that move through the economy to influence consumer prices, imports, exports, jobs, investment and GDP. While a tightening of the ETS cap will generally result in negative macro- and socio-economic effects, strengthened energy efficiency policies generally have the opposite effect.

3 The modelling study can be downloaded from: http://www.ecn.nl/docs/library/report/2013/e13033.pdf.

4 The modelling for this study was carried out assuming a relatively high carbon price (a baseline carbon price of 17 EUR/tCO_2) which in 2013 would be considered very high. 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.

While the ETS will increase profits for generators and increase costs for consumers, energy efficiency will reduce power prices for all consumers and reduce sales for power generators. Combining a tighter cap on CO_2 emissions with energy efficiency programmes, such as energy efficiency obligations, results in the cancelling out, at least partially, of these opposing wealth flows between utilities and consumers, serving decarbonisation goals while minimising negative impacts on the economy.

The multiple benefits of energy efficiency, extend even wider to encompass reduced air pollution, fuel poverty, public spending and need for generation and transmission infrastructure. The IEA has recently issued a report to provide comprehensive guidance on how to fully evaluate these multiple benefits and incorporate them into policy design. The latter could significantly enhance EU policy-making as step change improvements to energy efficiency could enable: cost-effective compliance with EU air quality legislation; and reduced investment requirements for generation, distribution and transmission infrastructure which are predicted to be extremely large in coming years and decades. Recent debates on "back-loading" the ETS allowance oversupply, and on tightening the overall European cap also reveal a political reality concerning energy price impacts of the ETS. In some Member States there is a concern in civil society over the impact on families and the incidence of "fuel poverty;" across Europe there is also a concern over weakening the competitive position of industry in global markets. In both cases, the concern over prices and bills acts as a practical limit to the ability of carbon pricing, acting alone, to drive decarbonisation at the pace that climate science and European policy require.

Evidence from experience: The Regional Greenhouse Gas Initiative in the US

Combining the ETS with energy efficiency policies can lower total CO_2 emissions from sectors outside the ETS. While the combined strategy will not lower total CO_2 emissions within the ETS capped sectors, it will lower the cost of the cap-and-trade system, neutralise negative effects on power bills and the economy, limit the need for exemptions, and make it politically easier to tighten caps. This is illustrated by the positive experience of the Regional Greenhouse Gas Initiative (RGGI), a carbon cap-and-trade scheme for the power sector now in its sixth year of operation across nine states in the Northeastern United States. Evaluation of the RGGI programme showed that the efficiency projects reduced emissions at costs ranging from approximately negative €43 to negative €81 per metric tonne of CO_2 reduction, yielding a weighted average cost of negative €59 per metric tonne.[5]

A particularly striking result of the RGGI architecture is the degree to which it has succeeded in its principal aim – emission reductions – despite the prevalence of low carbon prices in the region of €1,60-€2,40 per tonne. Through its first four years (2009-2012) the nine RGGI states invested over 80 percent of total auction receipts (more than €567 million) in clean energy and bill reduction efforts. The RGGI's original goal was to reduce emissions from 2005 levels by 10 percent by 2020. Partly because the emissions cap was overly-generous to begin with (like other cap-and-trade programmes), and partly because RGGI's investment strategy was successful, when the programme goals were revisited in 2013, there was strong political support to dramatically lower the cap. It is now set to reduce emissions below 2005 levels by more than 50 percent by 2020.

Carbon revenue recycling: Carbon revenues are just as important as carbon prices

By focusing on the strategic use of carbon revenues, and not just on the level of carbon prices, EU Member States could meet the fundamental objective of the ETS (carbon emission reductions at the lowest reasonable cost) while minimising rate and cost impacts on end-use customers. In particular, adding a robust energy efficiency programme to a cap-and-trade system funded by directly recycling revenues from auctioned allowances into the programme as in the RGGI experience, is a proven and effective way to offset a substantial portion of the power cost increases that consumers would otherwise face. Directly linking EU ETS auction revenues to needed energy efficiency investments of emissions sources within the ETS is thus a powerful means to accelerate and lower the cost of power sector decarbonisation and modernisation.

Since 2013, EU Member States have been receiving ETS auction revenues and are required to report to the European Commission on how these revenues are being spent. Some countries such as Germany, France, Czech Republic, Lithuania and Estonia are dedicating a considerable share of their ETS revenues on energy efficiency programmes. The European Council proposes the set up of a new reserve based on 2 percent of the EU ETS allowances and these funds will be used to improve

5 Based on an exchange rate of 0.81 euro to 1 US dollar.

energy efficiency and modernise the energy systems in low-income Member States. If invested in least-cost measures to modernise energy systems, and especially if spent through programmes that leverage much larger private investments in end-use efficiency, the 2 percent reserve could be an important step towards cost-effective decarbonisation as well as a shared commitment to European solidarity. Depending on the price of ETS allowances, however, the revenues flowing to energy efficiency investments would likely need to be much higher in all Member States in order to capture the large potential of energy efficiency and to follow the least-cost decarbonisation pathway.

While a high carbon price can have a disproportionate and negative effect on consumer bills, a low carbon price provides less incentive for investment in carbon reduction and also means lower EUA auction revenues for Governments to support energy efficiency programmes. ETS structural reform should therefore ensure timely adjustment of the GHG cap, taking into account the gains made by complementary policies such as efficiency programmes, European investment policies, renewables obligations and emission performance standards. The ambition levels of the EU ETS and energy efficiency strategy will need to be sufficiently stringent, well-coordinated to be complementary, and, importantly, ***both enforceable***. This suggests that the EU regulatory framework for energy efficiency needs to be considerably strengthened with, for example, binding energy efficiency targets for Member States. Using carbon revenue recycling as a strategic tool, European Member States will be able to drive low-cost savings into their economies and more easily reach the carbon targets and the 2050 trajectory of the EU Energy Roadmap for CO_2 reduction.

Recommendations

Based on the experience of many jurisdictions with energy efficiency investments, and the analysis and extensive modelling done for this report, we conclude that European and Member State decision-makers should:

- **Directly link EU ETS auction revenues to needed energy efficiency investments in order to accelerate and lower the cost of power sector decarbonisation and modernisation.** Because successful efficiency programmes require a stable source of funding across years, we recommend that a meaningful and stable fraction of carbon revenues (or a steady income stream from EUA sales) be reinvested in *additional* delivered efficiency measures to lower energy costs and bills for families and businesses.
- **To take advantage of the price- and bill-reducing impacts of enhanced efficiency, Commission recommendations and future decisions regarding the overall pace of carbon reductions should anticipate and take into account the accelerated progress that efficiency investments will deliver.** The pace of annual reductions should be raised. At first, this will be based on projections as to the impacts of efficiency investments, but as experienced is gained, the adjustment factors will be based on proven success. To maintain and manage this arrangement, a variety of mechanisms to improve *predictability in the pace of delivery* (on the efficiency side) and *flexibility in the supply of carbon allowances* (on the ETS side) could be used. Predictability on the demand side would be enhanced by strengthening the EU regulatory framework for energy efficiency, for example, through setting binding national energy efficiency targets. Responsiveness on the EUA supply side could be advanced through a variety of mechanisms, the most straightforward being a permanent improvement in the pace of carbon reduction towards and after 2030.

Whatever mechanisms are used, the underlying message of this report is that increased investments in energy efficiency in Europe would advance both economic and environmental goals, and permit more rapid progress towards decarbonisation while advancing European energy security and competitiveness. Harnessing carbon revenues to advance progress on carbon reduction is a powerful mechanism to achieve these goals.

1. Introduction

The power sector is the largest single source of industrial carbon emissions in the European Union (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.[6] This will require enormous investment in upgrading, replacing, and expanding critical infrastructure. Energy end-use consumers will ultimately pay for this and, given the European Union's sharp focus on economic recovery and improving global competitiveness, it would seem that minimising these costs to consumers should be a high priority for power sector regulators. Yet evidence across the European Union suggests that regulators are often not pursuing the least-cost pathway to decarbonisation.

On 23 October 2014, EU Member States agreed on a 2030 framework for climate and energy policy consisting of a domestic greenhouse gas (GHG) reduction target of at least 40 percent compared to 1990, an EU-wide target of at least 27-percent share of renewable energy in the energy mix, and a nonbinding energy efficiency increase of at least 27 percent, to be reviewed by 2020 having in mind an EU level of 30 percent for 2030.[7] Detailed policies and legislation to implement this framework are yet to be developed and adopted. The extent to which the EU's Emissions Trading Scheme (ETS) should or should not be supported by complementary policies and the role of the European Union are at the heart of the debate on the form of EU climate and energy policy architecture. This paper sets out why, from the perspective of safeguarding consumers' interests, sole reliance on the EU ETS is not the best pathway if our key objectives include advancing economic and social development.

Modelling results presented in this paper illustrate how, from an energy consumer's perspective, energy efficiency programmes deliver carbon savings at a much lower cost per tonne of carbon dioxide (CO_2) (tCO_2) saved compared with the EU ETS price acting alone. Legislators can establish a virtuous circle by using EU ETS revenues to support energy efficiency investment programmes, which in turn enables tightening of the ETS carbon cap sooner than that which would otherwise be politically possible. This paper concludes that binding and enforceable energy efficiency targets are needed at the Member State level, which requires intervention at the EU level, in order to ensure least-cost carbon reduction and complementarity with the EU ETS.

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

7 See the European Commission website, available at: http://ec.europa.eu/energy/2030_en.htm.

2. Why the EU ETS Is Unable to Harness Cost-Effective Energy Savings

If the ETS significantly raises power prices for consumers, won't consumers reduce their consumption of energy? In short, yes, but not by much. The price elasticity of demand for electricity has been closely examined and discussed in academic and expert literature.[8] Increases in the price of energy do not lead to a proportional decrease in demand. There is solid evidence extending over several decades that demand for electricity in our modern economy is relatively inelastic with respect to price and positively correlated with increases in income. Past experience and research has identified a wide range of financial, institutional, market, regulatory, technical, and information related barriers to energy efficiency (Table 1 on following page).

The short-term price elasticity[9] of demand in the European Union is no more than –0.1 to –0.2.[10] The long-term price elasticity for electricity is higher as people have more time to organise installation of energy-saving measures, but is also relatively small, from –0.25 to –0.32. This is still less responsive, however, than price elasticity for tobacco, an addictive product that has a price elasticity rate of –0.34 to –0.37.[11] Price elasticities are not necessarily constant and can vary over time, over income groups, across household sizes, by region, and also depending on whether prices are increasing or decreasing.

Rising incomes, however, will blunt any conservation effect created by carbon prices in the power sector. For example, in the United Kingdom the historical demand response figure for a 10 percent increase in power prices is –2.3 percent, but the income elasticity is such that a ten-percent increase in income results in an increase in demand of 3.4 percent.[12] Thus, household income is at least as important as power prices in determining the demand for electricity.

The above explains why very high prices are often needed to realise energy efficiency improvements, even if full payback over a short period of time is achievable. Alternatively, energy policies and programmes can be designed and implemented to overcome these many barriers and so exploit the valuable multiple benefits that energy efficiency has to offer.

8 See IEA reviews, including: Ryan L., et al. (2011, August). Energy Efficiency Policy and Carbon Pricing. IEA Information Paper, p. 20; Cooke, D. (2011, October). Empowering Customer Choice in Electricity Markets. IEA Information Paper, p. 16.

9 Price elasticity is the percentage change in quantity demanded in response to a 1 percent change in price.

10 See, e.g., Sijm, Hers, et al. (2008). *The Impact of the EU ETS on Electricity Prices.* Final Report to DG Environment of the European Commission. (ECN-E-08-007, p. 104). Available at: http://www.ecn.nl/docs/library/report/2008/e08007.pdf.

11 See, e.g., *Financial Times,* June 18, 2010, p. 14, reporting a study by UBS documenting an 8-percent demand decrease for cigarettes in response to a 25 percent price increase in 2009, and a demand reduction of one-third in response to an 87 percent price increase in tobacco over a period of several years.

12 Dimitropoulas, J., Hunt, L.C., & Judge, G. *Estimating Underlying Energy Demand Trends Using UK Annual Data.* Available at: http:///userweb.port.ac.uk/~judgeg/AEL_04.pdf.

Table 1

Typical Barriers to Energy Efficiency	
Barrier	**Examples**
Market	• Market organisation and price distortions prevent customers from appraising the true value of energy efficiency • Split incentive problems created when investors cannot capture the benefits of improved efficiency • Transaction costs (project development costs are high relative to energy savings) • Consumers remain passive as the benefits do not outweigh the "hassle factor"
Financial	• Up-front costs and dispersed benefits discourage investors • Perception of energy efficiency investments as complicated and risky, with high transaction costs • Lack of awareness of financial benefits on the part of financial institutions • Opportunity costs – consumers prioritise alternative investments
Information and Awareness	• Lack of sufficient information and understanding on the part of consumers to make rational consumption and investment decisions • Lack of advice on options
Regulatory and Institutional	• Energy tariffs that discourage energy efficiency investment (such as declining block prices) • Incentive structures encourage energy providers to sell energy rather than invest in cost-effective energy efficiency • Institutional bias toward supply-side investments
Technical	• Lack of affordable energy efficiency technologies suitable to local conditions • Insufficient capacity to identify, develop, implement, and maintain energy efficiency investments
	Source: Based on IEA 2010[13]

13 IEA Energy Efficiency Governance Handbook. (2010).

3. Role of the EU ETS and the Need for Regulated Efficiency Programmes

The McKinsey GHG marginal abatement cost (MAC) curve,[14] widely used by policymakers and modelers, illustrates how economically favorable energy efficiency measures are compared to alternative low carbon measures and technologies. Efficiency measures generally have a negative net abatement cost as the monetary value of energy savings exceeds costs over the lifetime of the measure, as illustrated in Figure 1. Although the left side of the curve shows the large potential for low-cost or negative-cost GHG reductions (i.e., efficiency actions that are already economic without a carbon price), many of these measures are not being implemented because of previously mentioned market barriers.

The right side of the MAC curve shows the abatement potential of higher-priced actions, including investments in nuclear power, renewable power, and fossil generation with carbon capture and storage. These investments are also not occurring for a variety of price, risk, and non-price barriers to deployment, and analysts understand that carbon prices would have to be reliably high over a long period of years in order to overcome these price and non-price challenges. Regulated and enforceable targets, research and development, and financial support are needed to drive commercialisation and deployment of new technologies.

The centre of the curve represents those abatement options in which a moderate carbon price might well stimulate investments and influence the dispatch order of electricity generation to yield emissions reductions. Although positive carbon prices and markets will support emissions reductions in all three regions of the curve, carbon prices alone will deliver only a portion of the total emissions reductions needed and will not be able to unlock the remaining reductions, at least not at least cost. In its publication *Summing Up the Parts*,[15] the IEA uses a schematic similar to Figure 1 to explain the role of the EU ETS in delivering carbon abatement economy-wide and the need for supporting policies. The accompanying text states:

> *"Pricing policies are inherently efficient, providing an incentive for abatement where it is most cost effective, have wide reach throughout the value chain, and cope well with uncertainty by not locking in particular technology choices. However carbon pricing needs to be flanked by supplementary policies to fully realise its least cost potential in light of the known market barriers and imperfections. [….]*
>
> *Carbon pricing, supplemented by cost-effective energy efficiency and technology policies to improve its short- and long-term efficiency are the "core" policies in a least-cost climate mitigation package. Without these supplementary policies, a higher carbon price than necessary would result. Policies to address infrastructure lock-in and investment barriers may also be needed."*

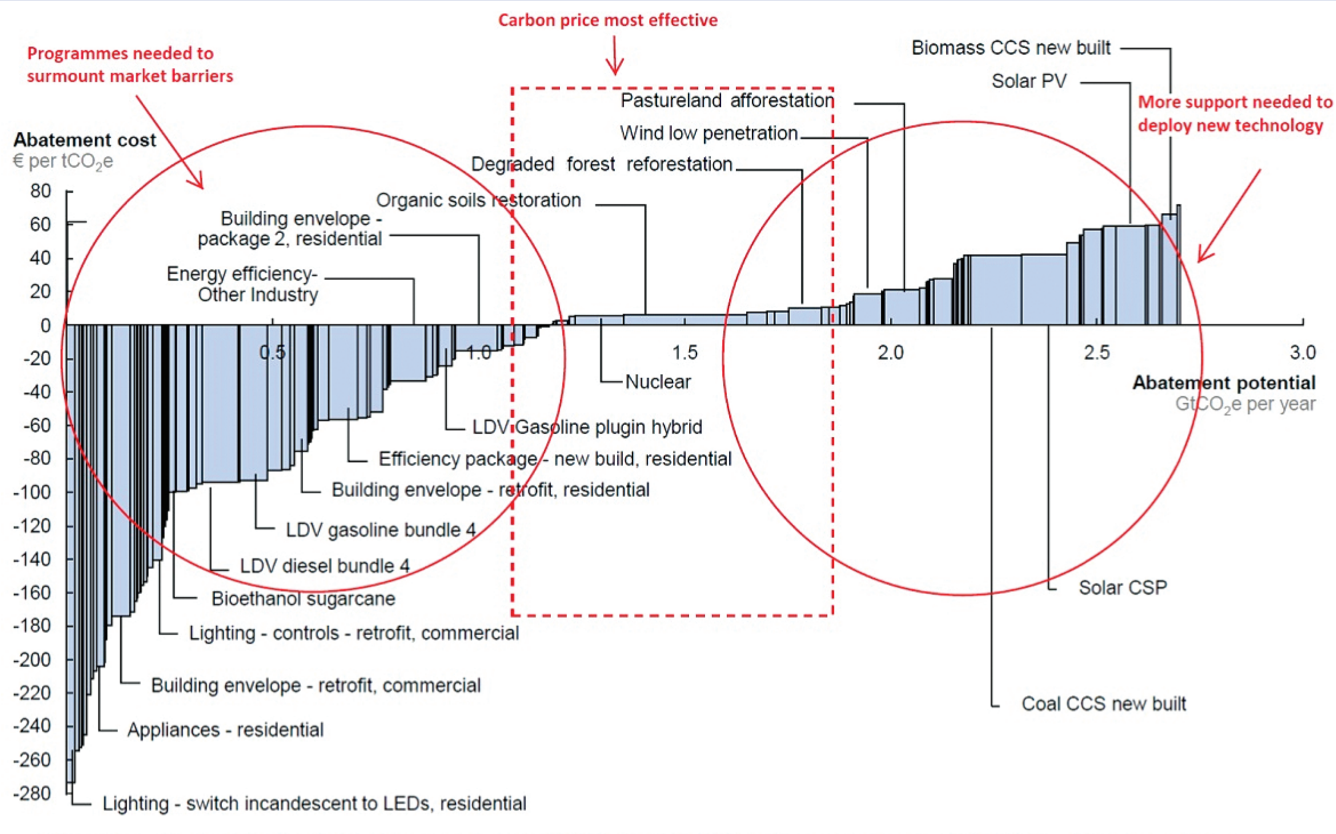
For a given cost to consumers, society can reduce much more carbon pollution through energy efficiency programmes than it can through pollution taxes or cap-and-trade programmes that focus only on the supply side. Experience from the United Kingdom demonstrates that a power system can realise nine times more savings from each euro spent in a well-managed efficiency programme – in megawatt-hours (MWh) and resulting GHG emissions – than it will through generalised, across-the-board price increases (see case study in Box 1).

14 McKinsey & Company. (2010). *Impact of the Financial Crisis on Carbon Economics: Version 2.1 of the Global Greenhouse Gas Abatement Cost Curve.*

15 Hood, C. (2011). *Summing Up the Parts: Combining Policy Instruments for Least Cost Climate Mitigation Strategies.* Paris, France: OECD/IEA, p. 8. Available at: https://www.iea.org/publications/freepublications/publication/Summing_Up.pdf.

Figure 1

EU27 GHG Abatement Cost Curve Beyond Business As Usual – 2030



Note: The curve presents an estimate of the mazimum potential of all technical GHG abatement measures below €80 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

Source: Global GHG Abatement Cost Curve v2.1

Box 1

Efficiency Programmes Will Save Nine Times More Carbon Than Power Price Increases Alone

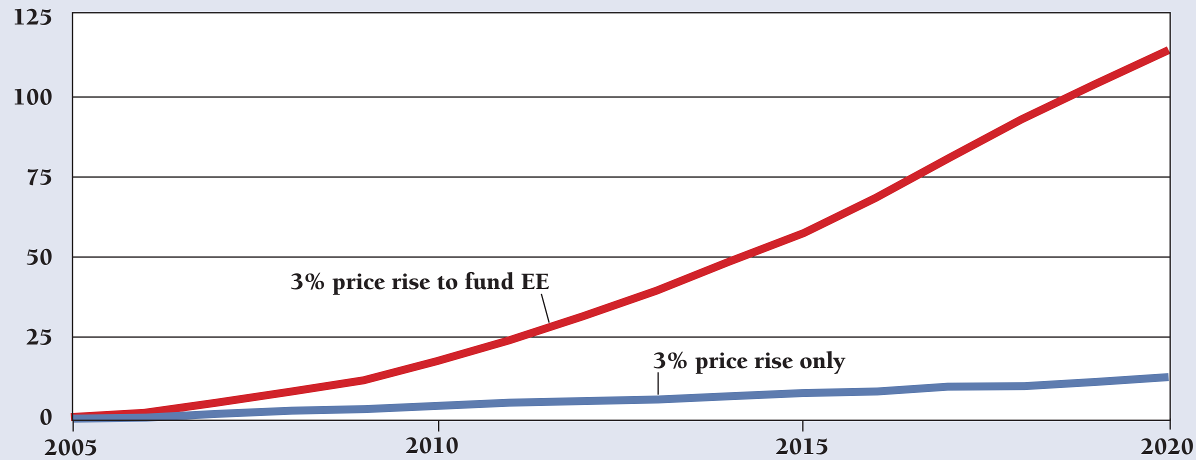
The following example demonstrates that a power system can realise nine times more savings from each Euro spent in a well-managed efficiency programme – in MWh and resulting GHG emissions – than it will through generalised, across-the-board price increases. The example calculates the reductions in GHG emissions likely to result from two cases using the generation, rates, and sales characteristics of electricity in the United Kingdom, combined with actual results of the United Kingdom's historic Energy Efficiency Obligation. Although the example is based on the power mix in the United Kingdom, the results would be similar in any jurisdiction with a high fraction of fossil generation. The example simply compares two options:

1. A one-off price increase of 3 percent in electricity prices, which will reduce electricity demand by 0.6 percent; and
2. Taking the same 3 percent rate increase and showing what happens when that revenue is invested in programmatic energy efficiency programmes similar to those delivered by energy retailers and governments in many jurisdictions.

Because of the low price elasticity of demand for electricity, the rate increase itself would result in a small decrease in demand and corresponding reduction in emissions, as indicated by the low gradient blue line in Figure 2. However, if the proceeds from a system benefit charge or carbon credit auction are invested in programmatic energy efficiency, the savings are much greater in both MWhs and in GHG emissions reductions, as illustrated by the much steeper red curve in Figure 2.

Figure 2

Investing a Price Increase in Energy Efficiency Saves Nine Times More Electricity Than That From a Price Increase



By Eoin Lees, based on Digest of UK Energy Statistics (DUKES) and Eurostat. Assumptions: levelised cost to electricity suppliers in the EEO for the period of 2005 to 2008 is €2 cents/kWh assumed constant in real terms from 2008 until 2020; real price of electricity is constant from 2008 to 2020; allowance for fall-off over time of electricity savings from shorter-lived measures and corrects for comfort (increased amenity); and underlying growth in electricity demand for households of 1.4 percent.

4. Macroeconomic Effects: Efficiency Provides Necessary Counterbalance to EU ETS

The McKinsey MAC curve, presented in Figure 1 of the previous section, is useful for comparing the costs of different technologies, but it can be criticised for not including the full value of the multiple benefits that energy efficiency investment can deliver, as valuation is limited to monetised energy savings.[14] In addition to directly reducing energy costs for those consumers implementing the measures, energy efficiency brings benefits across the power system in multiple ways, including lowering bills indirectly for *all consumers,* in particular by:

- lowering power clearing prices;
- lowering carbon prices;
- decreasing the demand for fossil fuels, which leads to lower wholesale fossil fuel prices; and
- reducing the need for infrastructure to generate, transmit, and distribute electricity.

The above points are in addition to the participant's benefits. Energy efficiency's downward effect on users' bills results in increased competitiveness for businesses, greater disposable income for families, greater gross domestic product (GDP), and reduced fuel poverty, among many other benefits (see section 5).

In this section we turn to a macroeconomic study commissioned by the Regulatory Assistance Project (RAP) and conducted by Cambridge Econometrics (CE) and Energy Center of the Netherlands (ECN), which illustrates how energy efficiency policies can complement the EU ETS in order to realise carbon emissions reductions at least cost. This particular study does not evaluate the full spectrum of multiple benefits that energy efficiency can offer. The IEA, however, has recently released a major study to inform regulators and practitioners on how to effectively evaluate the multiple benefits of energy efficiency; this is discussed later in section 5.

RAP commissioned CE and ECN to explore the interaction of energy efficiency investments with the carbon price and the resulting emissions reductions and macroeconomic and societal impacts. The study involved modelling three core scenarios[15] within a 2020 timeframe applied across the EU27 Member States:

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

The Energy-Environment-Economy Model for Europe (E3ME), developed by CE, was used to model the scenarios. E3ME is a computer-based model of Europe's economic and energy systems and the environment. It was originally developed through the European Commission's research framework programmes and is now widely used in Europe for policy assessment, forecasting, and research purposes. Key strengths of E3ME, which makes the model particularly appropriate for this research, relate to the close integration of the economy, energy systems, and the environment, with two-way linkages between each component.

The modelling for this study was carried out assuming a relatively high carbon price (a baseline carbon price of €17/tCO2), which at present would be considered very high compared with recent EUA prices of €5 to €6/tCO_2. 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 materially affect

14 Ekins, P., Kesicki, F., & Smith, A. (2011, April). *Marginal Abatement Cost Curves: A Call For Caution.* UCL.

15 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 European Union Allowance Units (EUAs, i.e., 1 tCO_2).

its ultimate conclusions. Although 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 2.

Box 2

The Merit Order, Power Clearing Prices, and Infra-Marginal Rent*

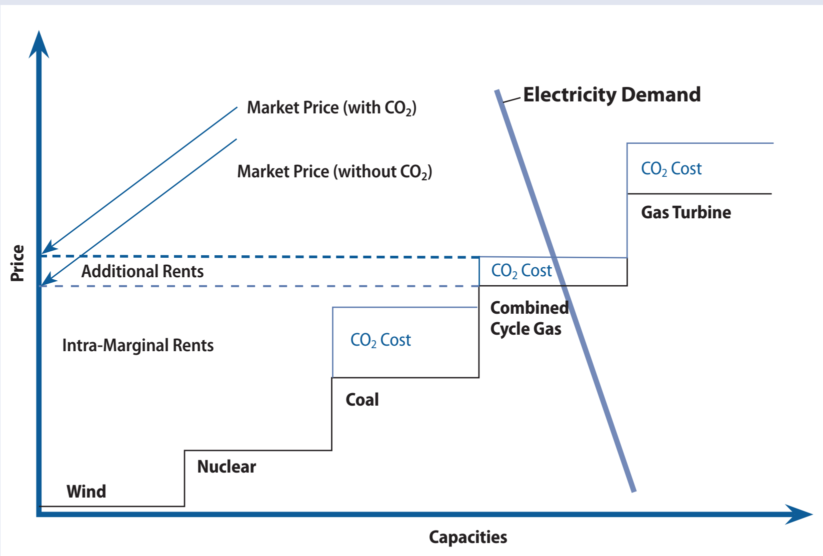
In liberalised electricity markets, as in Europe, retail electricity prices are no longer set by energy regulators on the basis of approved costs and an approved rate of return on investment; they are determined by the wholesale electricity market. In each market period, the market operator stacks up 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, although not always, tracks the underlying variable cost (per MWh) of the bidding resources. Such a cost-based merit order is illustrated in Figure 3 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 3, 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 supply curve. For the case illustrated, 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,** 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 income (economists call this portion of their income "infra-marginal rent").

Whenever a fossil unit is on the margin (which in Europe is 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 non-marginal fossil units benefit from this effect, as the higher clearing price will pay back some or all the cost of allowances, depending on its carbon intensity relative to the marginal plant.

Figure 3

Merit Order and Electricity Price Increase With CO_2 Price



** The merit order curve depicted here represents the short-term situation. In time, the curve will change shape with the transformation of the power sector owing to factors such as improved energy efficiency, market reforms that allow participation of energy demand and storage in power markets, and with continued growth in the share of low marginal cost generation.*

*** Except where out-of-market prices are used, when wind generators are simply paid a fixed price.*

Why the Cost per tCO_2 Actually Reduced Can Be Much Greater For Consumers Than the Market Price of ETS Allowances Would Suggest

Analysis in the aforementioned study, as in similar studies across Europe and North America (see Table 2 for comparison of studies), 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, owing to the carbon price raising the wholesale electricity price, passes through to consumer bills. The resulting power bill increase gives rise to a cost per tCO_2 reduced that is much higher than the carbon price paid for by generators. Essentially consumers are paying an unnecessarily high price for carbon emissions reductions, and much of this extra cost is being received by generators as profit.

The ECN and CE study illustrates the impact of energy efficiency on the change in total power bill per tCO2 (compare row iv of columns D and E in Table 2). Tightening of the GHG cap by 30 percent would raise the carbon price from €16.5 to €80/tCO_2, but would raise the cost to consumers by a factor of €6 to €478/tCO_2. If the tighter cap is combined with an energy efficiency obligation of one-percent p.a., then the cost is reduced to €162/tCO_2, along with 20-percent more carbon emissions reductions.

As the ETS can have a significant impact on power prices, this can in turn lead to important impacts on disposable income, which trickles through the economy to influence consumer prices, imports, exports, jobs, investment, and GDP. We now examine, in more detail, the macro- and socioeconomic effects of tightening the ETS cap and strengthening energy efficiency policies.

Table 2

Cost to Consumer per tCO_2 Reduction Relative to Carbon/Emissions Allowance Price

	Study, Author, and Year				
	A **PJM Study 2009**[16]	**B** **ECN 2008**[17]	**C** **ECN 2008**[18]	**D** **ECN and CE 2013**[19]	**E** **ECN and CE 2013**[20]
Study Assumptions/ Scenario		No demand response	With demand response	30% GHG cap	30% GHG cap, with EU energy efficiency obligation 1% p.a.
i Carbon price €/tCO_2	15	20	40	16.5 in 2008 rising to 80[21] in 2020	16.5 in 2008 rising to 65[22] in 2020
ii Total bill increase (billion €)	9	33	67	34	14
iii Power sector emissions reduction ($MtCO_2$)	14	133	363	71	87
iv Change in total power bill per tCO_2 reduced (€/tCO_2)	640	248	184	478	162
v Cost per tonne reduced as multiple of carbon price	43	12	4.5	6	2.5

16 PJM. (2009, January 23). *Potential Effects of Proposed Climate Change Policies on PJM's Energy Market.* p. 25.

17 See: http://www.ecn.nl/docs/library/report/2008/e08007.pdf.

18 Ibid.

19 See: http://www.ecn.nl/docs/library/report/2013/e13033.pdf.

20 Ibid.

21 2008 prices.

22 Ibid.

What Are the Macroeconomic Impacts of Tightening the GHG 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 (see "Tighter Cap Only" column in Table 3). This change results in the following:

- Lower fossil fuel use in the ETS sectors (including both industry and power generation);
- An increase in the carbon price paid by generators from €16.5 to €80 per tCO_2;
- An average increase in the total power bill for electricity consumers of €487 per tCO_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);
  - a 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:
- more 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.

Table 3

Combining Energy Efficiency Programmes With a Tighter Carbon Cap

	Baseline	Tighter Cap Only	Efficiency Obligation	Combined Approach
	21% GHG Reduction by 2020 Relative to 2005	*34% GHG Reduction by 2020 Relative to 2005*	*An EEO of 1% p.a.*	*34% GHG Reduction by 2020 Plus EEO of 1% p.a.*
	Absolute Values	% Change Compared to Baseline Scenario Unless Units Stated		
ETS Carbon Price in 2020 *(2008 prices; €/tCO_2)*	16.5	381.1 (€80/tCO_2)	–45.1 (€9/tCO_2)	292.1 (€65.2/tCO_2)
CO_2 Emissions *($MtCO_2$)*	3672	–4.7	–2.1	–6.8
Power Price *(€/MWh)*	107	11	–2	8
Total Power Use *(TWh)*	3198	–1.4	–3	–4
Total Power Bill *(€ bn)*	341	10	–4	4
Change in Total Power Bill per Tonne Reduced *(in €/tCO_2)*		€487/tCO_2	€–754/tCO_2	€162/tCO_2
GDP *(2000; Billion €)*	15443	–0.3	0.4	0.1
Consumption *(2000; Billion €)*	8710	–0.4	0.3	–0.1
Investment *(2000; Billion €)*	4041	–0.1	0.9	0.8
Exports *(2000; Billion €)*	8298	–0.5	0.3	–0.1
Imports *(2000; Billion €)*	8113	–0.4	0.3	0.0
Consumer Prices *(2008 = 1.0)*	1.2	0.9	0.0	0.7
Employment *(Million)*	233	–0.1	0.2	0.1
Real Household Incomes *(2000; Billion €)*	10833	–0.5	0.2	–0.2

What Are the Macroeconomic Impacts of an EEO?[23]

Compared to a tighter cap, an EEO (i.e., the "Efficiency Obligation" scenario in Table 3) 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 (although this is dependent on assumptions about wholesale gas and oil prices). Electrical energy efficiency delivers savings to consumers while lowering clearing prices across the entire wholesale power market. All participants will see lower clearing prices in wholesale electricity markets owing to lower demand generally. Consumers who invest in end-use efficiency will see *lower bills directly,* whereas all consumers benefit from lower *power prices* (and thus bills). Together, these effects can deliver large, positive macro- and socioeconomic impacts.

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

- Less infra-marginal rent for generators;
- Lower household electricity bills for all consumers;
- A decrease in the carbon price paid by generators from €17 to €9 per tCO_2;
- *An average benefit, not cost, in terms of lower power bills of €754 per tCO_2 reduction in the power sector;*
- Higher real incomes;
- More consumer spending;
- Greater industrial competitiveness;
- More employment; and
- Higher GDP.

What Happens When a Tighter GHG Cap Is Combined With Added Investments in Energy Efficiency?

Combining a tighter cap with energy efficiency investments through programmes results in the cancelling out, at least partially, of these opposing wealth flows between utilities and consumers. Although combining the policies will not lower total emissions within capped sectors, because the reductions they deliver can be taken up elsewhere, they can lower the cost of the cap-and-trade system, neutralise negative effects on power bills and the economy, limit the need for exemptions, and make it politically easier to tighten caps. This is illustrated in the figures for the "Combined Approach" scenario in Table 3. *Compared to tightening the cap in the absence of an EEO, the combined approach reduces the carbon abatement cost to the consumer by approximately two-thirds and also leads to:*

- much greater GHG and CO_2 emissions reductions as emissions reductions from both approaches are combined;
- a moderated carbon price resulting in:
  - some revenues for the Member State;
  - a neutral impact on the power clearing price as energy efficiency mitigates the increase resulting from a higher carbon price;
  - a reduced increase in the average household bill through lower power prices and lower electricity use; and
  - relatively neutral macro- and socioeconomic impacts.

It is clear from these modelling results that combining energy efficiency with a tighter carbon cap can achieve significant low-cost emissions reductions with neutral effects on the economy and wider society. Outcomes, however, depend on how the policy package is designed and implemented. Ambition levels of both policies would need to be sufficiently stringent, relatively evenly matched to be complementary, and, importantly, enforceable. This implies that the policies need to be coordinated in their design, implementation, and review. Furthermore, energy efficiency measures, even though the return on investment may be very attractive and achievable within a short timeframe, need to be financed, and this will likely require some amount of public finance in order to attract private finance.

The two policies can be directly linked to create a virtuous circle of low-cost carbon abatement by recycling ETS auction revenues directly into energy efficiency programmes. This is the approach that has been adopted by nine US states through their joint adoption of the Regional Greenhouse Gas Initiative (RGGI, pronounced "reggie"), founded upon an appreciation of the high value of the multiple benefits of energy efficiency, not just the monetary value of energy savings. This approach has enabled tightening of the region's GHG cap at an unprecedented rate relative to other regions around the world. Before elaborating on this particular example, the next section provides a brief overview on evaluating the multiple benefits of energy efficiency.

23 The analysis was undertaken before adoption of the Energy Efficiency Directive.

5. Evaluating the Multiple Benefits of Energy Efficiency

Broadscale investment in energy efficiency can provide many different benefits to many different stakeholders. The macroeconomic study discussed in the previous section illustrates the extensive economic benefits that can result directly from reducing energy demand and associated costs leading to investment in other goods and services. The full range of benefits resulting from energy efficiency improvements, however, extend much more broadly.

The IEA has recently issued a comprehensive publication, "Capturing the multiple benefits of energy efficiency," which attempts to bring together a wide variety of methodologies that can be used to assess the wide-ranging benefits that improved energy efficiency can bring. In addition to macroeconomic development, the IEA's in-depth analysis covers four other areas, including public budgets, health and well-being, industrial productivity, and energy delivery. We briefly examine each of these in turn below.

Energy efficiency improvements can lead to reduced government expenditures on energy, increased tax revenues through greater economic activity, and increased spending on energy effciency-related and other goods and services. A significant benefit can be the reduced budget for unemployment payments when energy effciency policies lead to job creation. One common misconception is that "Government cannot afford to dedicate revenues to efficiency programmes because they need the tax revenue." In fact, there is strong evidence that well-designed efficiency programmes will leverage private investment and add jobs and re-spending impacts that actually increase net governmental revenue. For example, an evaluation carried out by the Jülich Research Centre of energy efficient construction and refurbishment programmes funded by KfW Bankengruppe showed that every euro invested by KfW resulted in €4 to €5 of budget revenues for the German federal government.[24] Energy efficiency should also be a priority measure to reduce fuel poverty, improve air quality, and thus improve public health and reduce public health spending. Fuel poverty is prevalent across the European Union, particularly in central, eastern, and southern Europe.[25] Analysis of data by researchers from the University of York reveals:

- In 2011, 9.8 percent of households in EU27 and 15.8 percent of households in the 12 new Member States could not afford to heat their home adequately; and
- A total of 8.8 percent of EU27 households and 17.1 percent of households in the 12 new Member States were in arrears on their utility bills.

Targeted energy efficiency improvements could significantly reduce the extent of fuel poverty and related health effects in many Member States. For example, research undertaken in Northern Ireland on the impact of the Warm Homes Scheme 2000–2008 (a free, government-funded retrofit scheme for households in energy poverty) showed that every euro spent on house retrofits saved €0.42 in terms of health care no longer needed.[26]

The IEA's aforementioned publication presents evidence and case studies that illustrate high benefit/cost ratios for energy efficiency measures – as high as

24 KfW Bankengruppe. (2011, 27 October). *Energy-Efficient Construction and Refurbishment: Public Budgets Benefit Up To Fivefold From "Promotional Euros."* KfW press release. Available at: http://www.rockwool.nl/files/RW-BNL/7_Over%20Rockwool/7_3_Nieuws_Persberichten/2013/Persbericht_KfW_Juelich_Studie.pdf.

25 Thompson, H., & Snell, C. (2013, June). *Policy Brief: Energy Poverty in the EU*. The University of York. Retrieved from: www.fuelpoverty.eu. Findings are based on data from the EU Statistics on Income and Living Conditions (2011). Available at: http://www.eui.eu/Research/Library/ResearchGuides/Economics/Statistics/DataPortal/EU-SILC.aspx.

26 Liddell, C. (2008). *Estimating the Health Impacts of Northern Ireland's Warm Home Scheme 2000–2008*. Ulster: University of Ulster. Available at: http://eprints.ulster.ac.uk/26173/1/FPcostbenefitsonweb.pdf.

4:1 – when health and well-being impacts are included. The International Institute for Applied Systems Analysis has undertaken a number of modelling studies for the European Commission that identify large potential cost reductions and co-benefits that can be achieved through an integrated approach to assessment and delivery of multiple policy goals, particularly in relation to air quality and energy.[27] RAP has also written extensively on how to technically incorporate energy efficiency measures into the design of air quality programmes[28] and how to evaluate their benefits.[29]

Energy efficiency can also bring valuable benefits for industry. These benefits can be some 2.5 times greater than the value of the energy saved in the form of enhanced competitiveness, profitability, production, and product quality, as well as reduced costs for operation, maintenance, and environmental compliance.[30] Recent data from the European Commission show that energy efficiency improvements have helped maintain the European Union's competitiveness. In its recent analysis of energy prices and costs,[31] the Commission reported that *"there has been little impact on the EU's relative competitiveness which could be directly attributed to higher energy prices and the carbon price under the ETS, due to improvements in energy efficiency."*

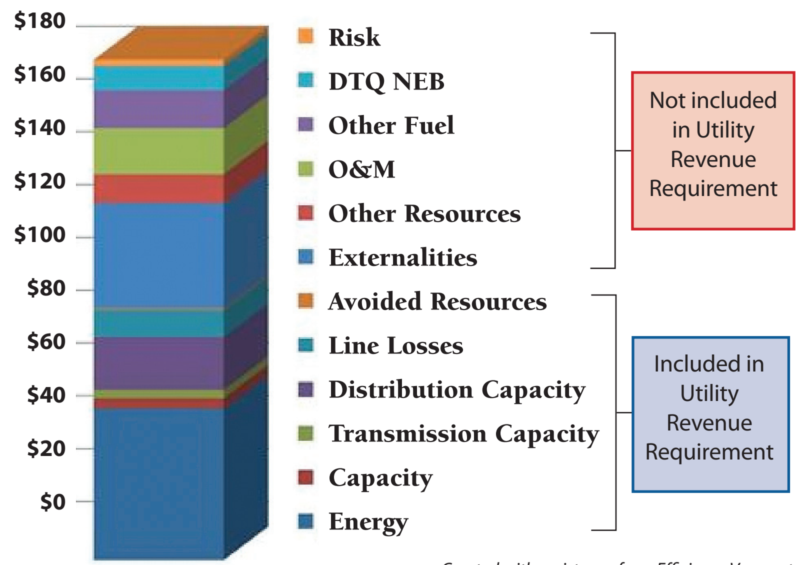
Utilities, energy providers, and their customers can also gain from the system benefits that more efficient energy delivery can bring. For example, reduced marginal line losses[32] and transmission congestion can lower power clearing prices, dampen volatility in wholesale electricity markets, improve system reliability, and delay system upgrades.

RAP recently conducted a full system evaluation for the case of Vermont.[33] By counting all direct and indirect benefits and savings attributable to energy efficiency, this analysis found that the *total value* of avoided energy use for the case of Vermont is substantially greater than the direct value of the energy savings alone, by a factor of five (Figure 4).

Figure 4

Vermont Energy Efficiency Savings Value

Updated Externality and NEB Values, $/MWh



Created with assistance from Efficiency Vermont, based upon data from their annual reports and personal communications.

27 Zusman, et al. (2013, April). Co-Benefits: Taking a Multidisciplinary Approach. IIASA. *Carbon Management* 4(2):135–137.

28 James, C., & Colburn, K. (2013, March 4). *Integrated, Multi-Pollutant Planning for Energy and Air Quality (IMPEAQ).* Montpelier, VT: The Regulatory Assistance Project. Available at: www.raponline.org/document/download/id/6440.

29 Shenot, J. (2013, August). *Quantifying the Air Quality Impacts of Energy Efficiency Policies and Programs.* Montpelier, VT: The Regulatory Assistance Project. Available at: www.raponline.org/document/download/id/6680.

30 IEA. (2014, September 9). Capturing the Multiple Benefits of Energy Efficiency. Available at: http://www.iea.org/topics/energyefficiency/energyefficiencyiea/multiplebenefitsofenergyefficiency/.

31 *Energy Prices and Costs in Europe.* European Commission staff working document, SWD(2014)20 final/2, Brussels 17.03.2014.

32 Lazar, J., & Baldwin, X. (2011, August). *Valuing the Contribution of Energy Efficiency to Avoided Marginal Line Losses and Reserve Requirements.* Montpelier, VT: The Regulatory Assistance Project. Available at: www.raponline.org.

33 Lazar, J., & Colburn, K. (2013). *Recognizing the Full Value of Energy Efficiency.* Montpelier, VT: The Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/6739.

34 Neme, C., Seefeldt, F., Offermann, R., Gottstein, M., Echternacht, D., Moser, A., & Weston, F. (2014). *The Positive Effects of Energy Efficiency on the German Electricity Sector.* Available at: http://www.raponline.org/document/download/id/7311.

A similar whole-systems approach was used to assess the wider benefits of energy efficiency for the case of Germany.[34] The study commissioned by RAP and carried out by Prognos found that:

- One saved MWh of electricity causes in the electricity system, depending on the underlying scenario, a cost reduction of €130 to €140 (2012 euro) per MWh by 2050.
- A significant increase of energy efficiency can reduce the long-term need to expand the German transmission grid by 8500 km down to a range of 1750 to 5000 km by the year 2050.
- By reducing the power consumption by 15 percent compared to a reference scenario, the CO_2 emissions can be lowered by 40 million tons and spending on coal and natural gas imports can be reduced by €2000 million (2012) in the year 2020.

Today's challenge for regulators is how to bring development and implementation of policies in line with research on co-benefits and application of evaluation methods. Unfortunately there exists much evidence in which policy development disregards the growing body of research and availability of more comprehensive assessment methods. There exists, however, a very good example in which politicians and policymakers took note of the evidence and applied lessons learned in order to advance achievement of their public policy goals. It was an understanding of the high value that energy efficiency improvements can bring to consumers, industry, and society – not a desire for a higher carbon price per se – which persuaded nine states in the United States to dramatically tighten their regional GHG cap in order to capture the multiple benefits of energy efficiency. We examine this example in more detail in the next section.

6. Carbon Revenue Recycling: The RGGI Experience and the European Challenge

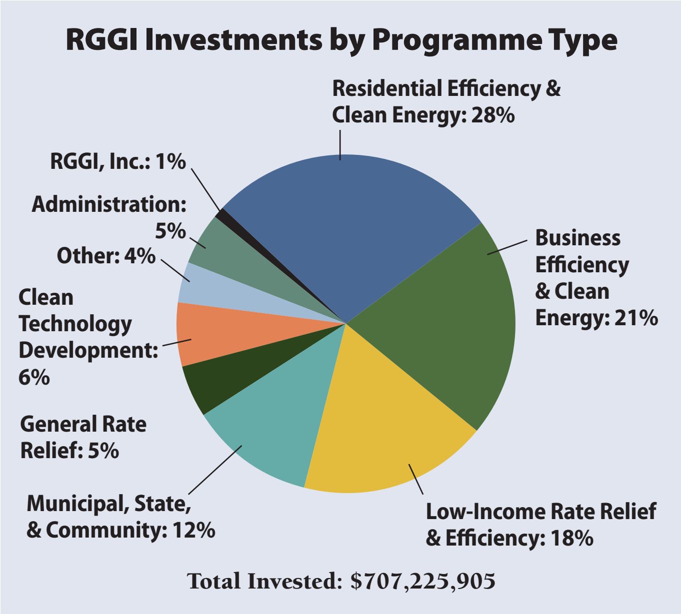
As previously explained in this paper, the consequences of high ETS allowance prices and energy efficiency market failures warn us that it can be surprisingly costly to consumers to rely on carbon prices alone to drive emissions reductions in the power sector. Higher carbon prices can deliver important price signals, but additional programme features are needed to protect consumers from increased power costs, to minimise transfer payments to generators, and to deliver lower-cost carbon reductions. By focusing on the strategic use of carbon revenues, and not just on the level of carbon prices, government could meet the true objective of the ETS (carbon emissions reductions at the lowest reasonable cost) while minimising rate and cost impacts on end-use customers. In particular, adding a robust energy efficiency programme to a cap-and-trade system, by directly recycling revenues from auctioned allowances into the programme, is a proven and effective way to offset a substantial portion of the power cost increases that consumers would otherwise face.

6.1 The Case of RGGI: Political Support for a 50 Percent GHG Reduction Founded on Appreciation of Energy Efficiency's Multiple Benefits

RGGI is a carbon cap-and-trade scheme for the power sector, now in its sixth year of operation across nine states in the northeastern United States.[35] During the planning process for RGGI, power and air quality officials from those states began to realise that the programme would be more effective and would cost families and businesses less if it could accelerate deployment of energy efficiency across the region.[36] The states agreed to commit at least 25 percent of their auction revenues to public purposes, such as clean energy, energy efficiency, and addressing fuel poverty. However, based on evidence on the leverage provided by greater efficiency, they have gone far beyond that and have in fact dedicated more than 60 percent of auction revenues to bolstering efficiency initiatives.

Even though the market price of allowances has been quite low, usually between $2 and $3 per tonne, the existence of the cap-and-trade programme has permitted the RGGI states to double their rate of spending on end-use efficiency. As reported by RGGI's administrators, through its first four years (2009–2012), the nine RGGI states have invested over 80 percent of total auction receipts (more than $700 million) in clean energy and bill reduction efforts (Figure 5).

Figure 5



35 Maine, New Hampshire, Vermont, New York, Massachusetts, Connecticut, Rhode Island, Delaware, and Maryland.

36 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, 33, 201-223.

What has this strategy accomplished? The RGGI 2012 annual report, in line with several independent studies, concludes:

"Investments of Regional Greenhouse Gas Initiative (RGGI) auction proceeds to date are projected to return more than $2 billion in lifetime energy bill savings to more than 3 million participating households and more than 12,000 businesses in the region. These programs are projected to offset the need for approximately 8.5 million megawatt hours (MWh) of electricity generation, save more than 37 million mmBTU of fossil fuels, and avoid the release of approximately 8 million short tons of carbon dioxide (CO_2) pollution into the atmosphere over their lifetime.

RGGI is making a difference for New England and Mid-Atlantic households, businesses, farms, and industry. The program has powered a $700 million investment in the region's energy future: reducing energy bills, helping businesses become more competitive, accelerating the development of local clean and renewable energy sources, and limiting the release of harmful pollutants into the air and atmosphere, while spurring the creation of jobs in the region. An independent 2011 study by the Analysis Group reported over 16,000 new job-years are being created as a result of investments made during the first three years of the program."[37]

These benefits are summarised in Table 4.

Another way of viewing the benefits of RGGI's strategy is to consider the cost of meeting its carbon goals on a cost-per-tonne basis. Because the state-mandated efficiency schemes are deploying cost-effective measures, and because they are large enough to substantially reduce consumption, early studies found that the cost of carbon reduction in the RGGI programme was actually negative (i.e., overall, RGGI reduced carbon emissions while saving consumers money). Evaluation of the RGGI programme showed that the efficiency projects reduced emissions at costs ranging from approximately negative €43 to negative €81 per metric tCO2 reduction, yielding a weighted average cost of negative €59 per metric tonne.[38]

Viewed through this lens, it is apparent that each tonne of reduction leveraged by way of RGGI-financed efficiency measures is both beneficial to consumers and an improvement in the societal cost-effectiveness of the carbon reduction programme.

Political Benefits of RGGI's Programme Design

A particularly striking result of the RGGI architecture is the degree to which it has succeeded in its principal aim – emissions reductions – despite the prevalence of low carbon prices. RGGI's original goal was to reduce emissions from 2005 levels by ten percent by 2020. Partly because the emissions cap was overly generous to begin with (like other cap-and-trade programmes), and partly because RGGI's investment strategy was successful, when the programme goals were revisited in 2013, there was strong political support to dramatically lower the cap. It is now set to reduce emissions below 2005 levels by more than 50 percent by 2020.

Especially telling are some examples of many public statements made at the time the programme was renewed

Table 4

All Programs Funded by RGGI

Participating Households To-Date: 3.2 million	**Energy Bill Savings** To-Date: $240 million Lifetime: $2 billion	**CO_2 Emissions Avoided** To-Date: 792,000 short tons Lifetime: 8 million short tons
Participating Businesses To-Date: 12,000	**Megawatt Hours Saved** To-Date: 928,000 Lifetime: 8.5 million	**Equiv. Cars Taken Off the Road** To-Date: 149,000 Lifetime: 1.4 million
Workers Trained To-Date: 3,600	**Million BTU Saved** To-Date: 2.5 million Lifetime: 37 million	

37 RGGI Inc. (2014, February). Regional Investment of RGGI CO_2 Allowance Proceeds, 2012, p. 3 (footnotes excluded).

38 Based on an exchange rate €0.81 to $1 US.

and this new cap was set. The decision to renew and deepen RGGI was made during challenging economic times, and needed to be approved in nine different states. The following quotes are typical of many statements made by political leaders and government officials at the time (emphasis added):

New York: *"In the past two years alone, New York and our neighboring states have experienced some of the worst storms in our states' history, and we can no longer choose not to act on the reality that our climate is changing," Governor Cuomo said. "The Regional Greenhouse Gas Initiative has been a tremendous success, reducing emissions here in New York and generating billions of dollars in green investment and economic development…"*

"RGGI offers compounded levels of clean energy and environmental benefits, as the State's auction proceeds are reinvested to support energy efficiency, renewable energy and advanced technologies, further reducing emissions while creating jobs and stimulating our economy," said Francis J. Murray, Jr., President and CEO, New York State Energy Research and Development Authority.

Delaware: *"Over the past five years, the RGGI states have demonstrated that a market-based program that spurs investments in energy efficiency and low-emission electric generation can simultaneously achieve the goals of cleaner, cheaper, and more reliable energy," said Collin O'Mara, Secretary of the Delaware Department of Natural Resources and Environmental Control.*

Connecticut: *"RGGI has been an enormous success in reducing carbon emissions, providing incentives for cleaner power generation, improving air quality, and funding clean energy initiatives – all at a minimal cost to electric ratepayers," said Daniel C. Esty, Commissioner of the Connecticut Department of Energy and Environmental Protection. "The changes in the program put forward today will allow us to continue moving toward a cleaner energy future in a manner that is consistent with the need to keep power cheap, strengthen our economy, and grow jobs."*

Is There Carbon Revenue Recycling in Europe?

With the beginning of ETS allowance auctions, European Member States now have a new opportunity to capture auction revenues and dedicate them to investments that will both lower emissions and build European economies. Article 10 of the ETS Directive[39] states that Member States will determine how ETS revenues generated from the auction of ETS allowances will be used. The article, however, also states that Member States should spend 50 percent of the revenues on one or more listed measures, many of which would help to accelerate progress on the path to decarbonisation.[40] Investments in energy efficiency are included on this list, but are not given a higher priority than any of the other Member State options.

Member States are obliged to report on the spending of revenues[41] and must use a standard reporting template.

Are carbon revenues being used to enhance energy efficiency? Analysis of submissions for the first reporting year show that several Member States are recycling between 50 percent and 100 percent of revenues into climate and energy measures, with some giving priority to energy efficiency programmes (see Table in Annex 1). Some Member States report that they do not hypothecate funds (dedicate Treasury receipts to particular purposes), and instead report detail on existing programmes that meet the criteria of Article 10 up to the value of 50-percent ETS revenues received (e.g., Poland, United Kingdom, Austria). Through these reports it is impossible to tell whether the creation of the new ETS new revenue stream has led to additional investments in low-carbon assets. The analytical problem is determining whether the spending of ETS revenues is additional to what would have been spent anyway in the absence of these extra revenues. There may be a tendency for Member States

39 Council Directive 96/61/EC and 2003/87/EC.

40 Contribution to the Global Energy Efficiency and Renewable Energy Fund and Adaptation Fund; to develop renewable energies and other low-carbon technologies to help meet the European Union's 2020 renewable energy and energy efficiency targets; measures to avoid deforestation and increase afforestation and reforestation; forestry sequestration; carbon capture and storage; low emission and public transport; finance for research and development in energy efficiency and clean technologies; measures to increase energy efficiency and insulation or to provide financial support in order to address social aspects in lower and middle income households; and for administrative management of the Community scheme.

41 Regulation 525/2013 on a "Mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change." (2013, May 21).

to displace existing climate and energy policy budgets with the new incoming ETS revenues, or simply to report that their pre-existing programmes met the 50-percent goal suggested in the ETS legislation. Unfortunately, considering the intense pressures on Member State budgets, there will always be a tendency to use ETS receipts to address short-term budget gaps rather than to invest in longer-term carbon reduction measures (even those efficiency measures proven to promote economic growth). Escaping this trap requires political leadership and a recognition that the economic benefits will soon prove themselves. In the RGGI states, for example, carbon revenues did not just substitute for other spending; during the first years of RGGI, overall spending on programmatic energy efficiency doubled across the nine-state region.

7. How ETS Revenues Are Spent Is More Important Than ETS Price

The previous example of the RGGI illustrates the high value of the multiple benefits of energy efficiency and how they can be captured using public funds representing just a small fraction of efficiency's full value. There will no doubt be competing calls on how the EU ETS revenues should be spent, including the need to support clean technologies that are not yet commercially competitive. The case of the RGGI illustrates that high-value benefits can be achieved even if the carbon price and resulting revenues are not very high.

In deciding whether to dedicate an absolute amount or proportional amount of revenues to energy efficiency programmes it could seem a reasonable proposition to adopt a proportional approach as the higher the carbon price, the greater the consumer's need for energy efficiency. However, there can be a significant lag between collection of revenues and realisation of the benefits from investment in energy efficiency (e.g., a whole-house retrofit may take many months or even years to plan and deliver). Furthermore, from the consumer's perspective, particularly the most vulnerable or those classified as fuel- or energy-poor, it is preferable that energy efficiency improvements are delivered ahead of increases in the carbon price that come with tightening the cap. Thus, the proportion of revenues recycled to energy efficiency may need to start on the high end, and could then change with time as programmes mature and impacts are understood.

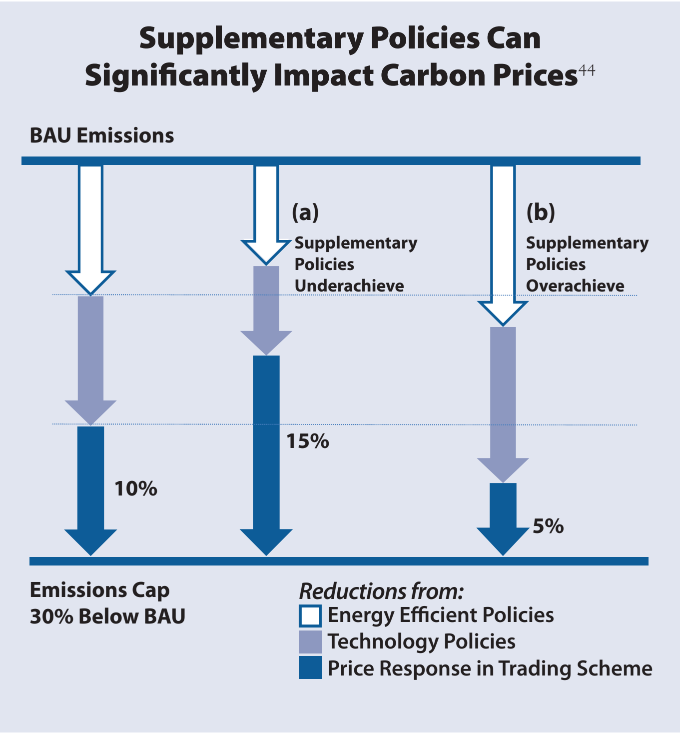
Given that investment in energy efficiency is a least-cost (indeed, negative-cost) strategy relative to the other decarbonisation options and that energy efficiency is needed to soften the negative impacts of higher carbon prices, it would be desirable to secure a stable and minimum revenue stream to ensure consumer protection through energy efficiency improvements. However, by lowering energy demand, energy efficiency investment also reduces the EU ETS price. It is therefore necessary to carefully consider how energy efficiency policies interact with the EU ETS and how they can be designed to be as complementary as possible. We turn to this in the next section.

8. Careful Policy Design Can Maximise the Benefits of Complementary Policies

Across all jurisdictions that use emissions trading as a policy tool, a number of parallel tools exist to promote emissions reduction via other means. If well designed, renewables standards, power market rules, and energy efficiency programmes can lower the societal cost of reducing emissions. On the other hand, if poorly designed or implemented, they could interfere with carbon markets, add investor risk, and raise the total cost of reaching long-term carbon objectives.

The carbon price will decrease or increase depending on many factors, including the effectiveness of other decarbonisation policies. For example, if the parallel policies are not adequately implemented and their performance turns out to be weaker than expected, then the carbon price and the cost to consumers per tCO_2 reduced will turn out to be higher than expected (as illustrated in scenario A, Figure 6). If the effectiveness of supplementary policies are underestimated relative to the target cap, then the lowering effect on the carbon price will be greater than expected and a relatively low carbon price will result (as illustrated in scenario B, Figure 6).[43] Whether a lower carbon price by itself is a good thing or a bad thing is a matter of some debate, as Europe's recent debates over ETS backloading and the proposed Market Stability Reserve amply demonstrate. Whatever the level of carbon prices, it is clear that a workable combination of public policies must address European goals and global needs for a steady and rapid pace of decarbonisation over the coming decades.

Figure 6



The conclusion that energy efficiency has the potential to drive down the carbon price does not mean that ambition on energy efficiency should be tempered. Rather, it points to the need to coordinate the design of the ETS with energy efficiency in a way that ensures that the carbon price remains within desired limits while implementing ambitious energy efficiency programmes and policies.

Figure 6 demonstrates the need to ensure that policy delivers as expected. Underachievement, as shown in scenario A, is an undesirable outcome, as this results in a higher than expected carbon price, which has negative consequences for consumers and the economy. This would be happening today, as in recent years the European Union has underachieved on implementation of energy efficiency policy, for example, major delays in implementing and revising the Energy Performance Directive for Buildings and delays in revisions of outdated

43 In addition, there could be changes in the business-as-usual baseline assumptions as has been the case in the last five years, owing to economic recession unexpected at the time of setting the ETS cap. Changes to baseline assumptions cause the top horizontal line in Figure 5 to move up or down and this also impacts the carbon price.

44 IEA, 2011. (See footnote 15.)

labelling schemes (e.g., fossil-fuelled boilers). The carbon price, however, has been very low largely owing to economic recession, and so has countered the effect. In the future, to prevent underachieving complementary policies resulting in an unreasonably high carbon price and politically unacceptable power price increases, regulators could ensure that energy efficiency policies are binding and enforceable in order to best ensure predictable reductions in ultimate demand, and greater complementarity with the EU ETS cap.

Overachievement of energy policies, as shown in scenario B of Figure 3, would be a better outcome for consumers relative to scenario A, but this would risk credibility of the carbon price, as a market signal and governments would receive lower ETS revenues than expected. The latter would be particularly undesirable if complementary policies are too dependent on these revenues. It also needs to be remembered that external factors out of the control of market actors and regulators, such as recession or higher than expected growth, can also impact the carbon price.

Although a high carbon price can have a disproportionate and negative effect on consumer bills, a zero or very low carbon price reduces the incentive for investment in carbon reduction and also means no or low EUA auction revenues for governments needed to support energy efficiency programmes. Because of concerns about the volatility of the carbon price and the risk for too high or too low a price, the European Commission has proposed the introduction of a Market Stability Reserve.[45] This is intended to ensure a reasonable ETS price will exist and so should provide greater assurance that Member States will receive expected revenues.

In the longer run, ETS structural reform should be aimed at continuous progress toward much lower emissions, which is not just a function of the carbon price. The low-carbon transition is measured by the rate of reduction in the cap, which is accompanied by price changes, but also by the pace of success in the necessary suite of complementary policies. Thus, there is a dynamic relationship among the carbon cap, the carbon price, and each of the major complementary policies. 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. The EU regulatory framework for energy efficiency needs to be considerably strengthened, both to ensure greater predictability in carbon prices and to reduce the total social cost of the low-carbon transition.

One way to creatively and positively link carbon pricing and energy efficiency would be through the rules governing the Market Stability Reserve. As now proposed, when the number of unused allowances in the system reaches a set level, allowances in the Reserve would be released, leading to lower prices for allowances and easing carbon price impacts on consumers. A more effective strategy would be to sell the allowances and dedicate the additional revenue to additional efficiency investments at business and household end-use locations. Those investments would lower demand for energy and allowances, and thus carbon prices (just as intended by the Reserve policy), but they would also lower energy bills for European business and families and add to economic growth. Tightening of the cap should, as a minimum, follow a trajectory to 2050 aligned with the EU Low Carbon Economy and Energy Roadmaps. It may be possible to tighten the cap more quickly than expected if, as in the case of RGGI, the policy package overachieves in delivering cost-effective emissions reductions. The challenge is to effectively coordinate the EU ETS with energy efficiency policies. Both the ETS cap and the contribution of energy efficiency to meeting this cap would need to be reviewed periodically, along with the performance of other complementary measures, as part of a robust climate and energy policy governance framework involving fit-for-purpose monitoring and correction mechanisms.

45 For further information on ETS structural reform, see: http://ec.europa.eu/clima/policies/ets/reform/index_en.htm.

9. Regulators Recognise the Need For Complementary Policies

The US Environmental Protection Agency issued proposals on June 2, 2014 that would apply power sector carbon intensity targets to each US state, tailored to take into account differing characteristics of each state. The proposals, however, do not mandate how those goals should be achieved. Instead the Environmental Protection Agency proposes an extremely flexible approach encouraging implementation of a wide variety of complementary measures. Emissions reductions can be achieved through measures such as plant heat rate improvements, system-wide energy efficiency improvements, plant retirements, and growth in generation from renewable energy sources. States can also collaborate to implement region-wide measures, including cap-and-trade schemes.

Some US states are already very experienced in combining measures to achieve cost-effective carbon emissions reductions. For example, California uses supplementary policies within its capped sector in order to achieve emissions reductions as cost effectively as possible. In its recently updated policy strategy, the California Scoping Plan,[46] the California Air Resources Board reported the following:

> *"The Cap-and-Trade Program establishes an overall limit on GHG emissions from most of the California economy—the 'capped sectors.' Within the capped sectors, some of the reductions are being accomplished through direct regulations, such as improved building and appliance efficiency standards, the Low Carbon Fuel Standard, and the 33 percent Renewable Portfolio Standard. Whatever additional reductions are needed to bring emissions within the cap is accomplished through price incentives posed by emissions allowance prices. Together, direct regulation and price incentives assure that emissions are brought down cost-effectively to the level of the overall cap."*

The EU ETS was introduced in 2005 and is now in its third phase. Soon after its introduction, EU politicians adopted a complementary policy approach to combat climate change, increase the European Union's energy security, and strengthen its competitiveness. Three targets were set –known as the "20-20-20" targets: to reduce GHGs by 20 percent, increase the share of renewable energy sourcesby 20 percent, and increase energy savings by 20 percent.[47] This framework has provided the direction and support for the many low-carbon programmes and policies (e.g., building codes, utility efficiency programmes) delivered by EU Member States, local governments, and utility administrators. Going forward, as carbon reductions become more challenging to deliver, it is critical that the European Union's complementary policy framework be strengthened and that governance structures be sufficiently robust.

The European Union's complementary policy approach has, however, been strongly criticised by some who believe the ETS, on its own, can deliver the least-cost decarbonisation pathway. Critics have blamed the low carbon price experienced in recent years on energy efficiency regulations and renewable energy subsidies alongside the impact of the recession. It can be argued, however, that these complementary policies have achieved emissions reductions much earlier and at a much lower cost than could have been achieved through an equivalent carbon price. As discussed earlier, a successful complementary policy approach requires careful design to ensure trade-offs are effectively managed. The European Commission has recognised the need for attention to this to some extent, as it proposes that the 2030 policy framework be based on ***"Simplification of the European policy framework while improving complementarity and coherence between objectives and instruments."***[48]

46 California Air Resources Board. (2014, February). *Proposed First Update to the Climate Change Scoping Plan: Building on the Framework*. Available at: http://www.arb.ca.gov/cc/scopingplan/2013_update/draft_proposed_first_update.pdf.

47 The GHG target is relative to 1990 and the RES and energy efficiency targets are relative to 2005.

48 COM(2014) 15. (2014, January). *A Policy Framework For Climate and Energy in the Period 2020 to 2030*. 22.01.2014. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2014:0015:FIN:EN:PDF.

10. Conclusion

The EU ETS is an important tool to guide power markets and investments; however, carbon pricing alone will not deliver the GHG reductions needed in the power sector – certainly not at least cost nor at an acceptable cost to society. Market barriers to energy efficiency investment are too great to be addressed through prices alone; well-designed and properly implemented programmes and regulations are needed to unlock the substantial multiple benefits of energy efficiency.

Reformation of the electric power sector is central to achieving needed carbon reductions, and it is the most important sector governed by the ETS. However, as a consequence of the merit order effect, wholesale power markets can multiply the cost of carbon prices to consumers and confer windfall profits in the form of transfer payments on many generators. As the carbon price increases, so do consumer power bills, ultimately leading to negative macro- and socioeconomic impacts, together with political resistance to lower carbon caps. Energy efficiency improvements move all these effects in the opposite direction.

This creates the opportunity for an intentional linkage between the carbon reduction scheme and the policies for energy efficiency. Combining a tighter cap with greater investments in energy efficiency, such as through energy efficiency obligations, moderates the wealth flows between utilities and consumers. As energy efficiency lowers the carbon price and power clearing price, space is created to tighten the EU ETS carbon caps while at the same time realising multiple co-benefits, such as reduced air pollution, improved industrial competitiveness, reduced fuel poverty, and increased GDP.

While a high carbon price can have a disproportionate and negative effect on consumer bills, a low carbon price provides less incentive for investment in carbon reduction and also means lower EUA auction revenues for Governments to support energy efficiency programmes. ETS structural reform should therefore ensure timely adjustment of the GHG cap, taking into account the gains made by complementary policies such as efficiency programmes, European investment policies, renewables obligations and emission performance standards. The ambition levels of the EU ETS and energy efficiency strategy will need to be sufficiently stringent, well-coordinated to be complementary, and, importantly, ***both enforceable***. This suggests that the EU regulatory framework for energy efficiency needs to be considerably strengthened with, for example, binding energy efficiency targets for Member States. Using carbon revenue recycling as a strategic tool, European Member States will be able to drive low-cost savings into their economies and more easily reach the carbon targets and the 2050 trajectory of the EU Energy Roadmap for CO_2 reduction.

Table 5

Use of ETS Revenues in EU Member States[49]

Country	2013 Reported Revenues (2012 Carryover) in Thousands of Euro	% Recycled to Article 10(3) and Article 3d(4) of Amended Directive 2003/87/EC	Hypoth-ecation or Recycling of Funds?	Some Funds Invested in Energy Efficiency?	Description
Germany	790,292 (195,000)	Almost 100%	Y	Y	ETS revenues go to the Special Energy and Climate Fund (established by law in 2010 and kept separate from the Federal Budget)
Italy	385,890 (76,497)	50%	Y	Y	Not yet distributed, but 50% in all years will be committed according to Articles 10(3) and 3d(4). From 2016 on, the other 50% will be allocated to the general budget, but until then the funds will be used to reimburse new entrants from 2008¬2012 who did not receive the free allowances to which they were entitled.
France	219,247	100%	Y	Y	Revenues are committed to the National Agency for Housing, which implements energy efficiency refurbishment of buildings, especially for low-income families (Habiter Mieux programme)
Romania	122,736	74%	Y		Revenues used for financing of public transport works (subway, buses) and afforestation
Czech Republic	80,686	91%	Y	Y	ETS revenues support the Green Savings Programme, a financial support scheme designed to promote energy saving measures carried out by households, focused toward refurbishment of private dwellings (insulation), construction of new dwellings in low-energy or passive standard, and utilisation of low-emission or renewable sources of heating in households
Netherlands	134,238,000*	Unknown	N		Strict separation of income and expenditure (i.e., revenues are not hypothecated) (€134 *billion* actually reported on EIONET – ***suspected error**, correct amount assumed to be €134 *million*)
Greece	147,638	100%	Y	N	According to national legislation, for 2013-2015 the total ETS revenues will be allocated to a Special Account for Renewable Energy.
Belgium	114,992	Unknown			The revenues are blocked in an account, as no cooperation agreement has been established between the federal and regional governments regarding their distribution.
Bulgaria	52,629,000* (22,138,000)	97%	Y		Revenues used to support renewable energy generation; possibly also for energy efficiency (not clear in report) (€52.6 *billion* actually reported on EIONET – ***suspected error**, correct amount assumed to be €52.6 *million*)
Finland	66,970	3%			Revenues used to fund adaptation-related activities through Least Developed Countries Fund
Slovakia	61,702 (12)	0.1%	N	N	Payment of fees relating to ETS auction
Austria	55,752	100%	N		Austria does not hypothecate/recycle revenues; it therefore reports existing activities up to the value of 50% of the revenues received and states that spending on climate- and energy-related programmes far exceeds this amount

49 Data available at: http://rod.eionet.europa.eu/obligations/698/deliveries.

***Table 5**, continued*

Use of ETS Revenues in EU Member States

Country	2013 Reported Revenues (2012 Carryover) in Thousands of Euro	% Recycled to Article 10(3) and Article 3d(4) of Amended Directive 2003/87/EC	Hypothecation or Recycling of Funds?	Some Funds Invested in Energy Efficiency?	Description
Ireland	41,677 (100)	100%	Y	Y	36% of funds disbursed to energy efficiency through retrofitting of dwellings; 60% disbursed to planting of new forests in Ireland
Latvia	10,791 (2219)	0.1%	N	N	0.1% revenues used for ETS administration-related costs
Luxembourg	4985 (368)	50%			No breakdown of spend reported; decision due September 2014
Malta	4466	64%	Y	Y	Revenues recycled to renewable energy support schemes (solar water and photovoltaic) and 3% to roof insulation and double glazing
Portugal	72,782	98%	Y	N	Large proportion recycled to support of renewable energy generation technologies; also carbon sequestration, land use, N_2O emissions reduction, electric vehicle charging, and various international programmes
Slovenia	17,739 (3512)	50%	Y	N	Recycling of funds to support renewable energy generation technologies and sustainable transport
Spain	346,111 (68,533)	100%	Y	N	Substantial proportion to support of renewable energies; also transport and water-related programmes/policies
Sweden	35,700	100%	Y	Y	Support for clean vehicle procurement, sustainable energy technologies, and energy efficiency in industrial processes
Hungary	34,592	50%	Y		Central budget and Green Economy Financial Scheme
Estonia	18,074	50%	Y	Y	50% of the revenues will be recycled to support energy-saving measures and renewables in apartment buildings
Lithuania	19,978 (3286)	100%	Y	Y	77% of ETS revenues to be spent on refurbishment of public buildings and multistory residential buildings
United Kingdom	485,361	100%	N		HM Treasury does not hypothecate revenues; the United Kingdom reported that government spending on climate and energy programmes far exceeds the value of 50% of the auction revenues
Poland	244,022	50%	N		Poland does not hypothecate revenues; Poland reported that government spending on climate and energy programmes exceeds the value of 50% of the auction revenues
Croatia					Data has been reported to Commission portal but is not yet available for public view.
Cyprus	1,928	100%	Y		533,000 euro of the total allocated to: measures to avoid deforestation, demolition of livestock warehouses as farmers leave profession, research for adaptation of agriculture to climate change, and administrative expenses of ETS.

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