Steve Caldwell

Professor Brewer

MARK-609 Climate Change and Energy Issues for Business

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The Energy Efficiency "Paradox"

Climate change is an issue of significant and growing concern for policymakers, corporate executives, and the general public. Several nations have already adopted greenhouse gas (GHG) emissions reduction targets. Climate change legislation is currently pending in the US Congress, and all three US presidential candidates support regulation of GHG emissions. In light of existing and proposed GHG emissions caps, governments and firms need to understand the costs of reducing GHG emissions. Some studies report significant opportunities for negative cost GHG abatement (Lovins 2005, McKinsey 2007, Vattenfall 2007a). It is important for policymakers and businesses to critically examine these claims. Policymakers must investigate negative cost GHG abatement opportunities in order to remove any barriers to their achievement in order to minimize the social cost of climate change mitigation. Corporate executives should pay careful attention to negative cost GHG emission reductions since their very existence would indicate the opportunity for profitable investments irrespective of GHG regulations. Moreover, firms can comply with GHG regulations at least cost by adopting negative and low-cost emissions reduction options first. To the extent that a firm can exploit any such options better than other firms, it may achieve a competitive advantage under a GHG regulatory regime. This paper presents the details of some negative cost GHG abatement claims, reviews the theoretical and empirical evidence for and against such claims, examines some case studies of corporate energy efficiency programs and revealed best practices, and proposes government policies to encourage the exploitation of negative and low cost GHG abatement opportunities.

Since the energy crises of the 1970s, economists and engineers have studied and argued about the potential for and costs of improvements in energy efficiency. Golove and Eto (1996) describe the debate over the “efficiency gap.” Golove and Eto split the “efficiency gap” into two components. First, they claim that individuals and firms fail to undertake profitable investments in energy efficiency based solely on private interest and market prices. Second, the authors argue that individuals and firms under-invest in energy efficiency from the perspective of aggregate social welfare since market prices do not take into account the negative externalities associated with energy production (e.g. climate change). This paper focuses on the first component of the “efficiency gap” (i.e. unexploited profitable energy efficiency investments) and refers to it with the term “efficiency paradox,” borrowed from the relevant literature.

Some energy efficiency optimists propose that the potential for negative cost GHG abatement is very large. Amory Lovins, the founder of the Rocky Mountain Institute (RMI), believes that opportunities to reduce energy usage at a profit abound in the economy. For example, Lovins (2005) describes how RMI created new designs for constructing such things as data centers, chemical plants, and supermarkets that use from 75-90% less energy than standard designs while also lowering capital costs. While the views of RMI tend to be more optimistic than most, recent important studies also make claims for significant negative cost GHG abatement opportunities. The McKinsey Global Institute (2007) estimated the potential for increasing energy productivity (GDP per unit of energy consumed) and thus lowering GHG intensity (the ratio of GHG emissions to GDP) by investing in energy efficiency projects with internal rates of return (IRRs) greater than 10%. The McKinsey study calculated that such investments would allow the US to increase its energy productivity enough to cap or slightly reduce its energy usage (and thus GHG emissions) through 2020 even assuming business-as-usual economic growth (see Figures 1 and 2 for details). McKinsey reports that the commercial and industrial sectors represent 16% and 35% of total US energy demand respectively and estimates that energy efficiency investments by these sectors would 14% and 17% of the total potential gain in energy productivity.[1] For example, McKinsey finds profitable opportunities (assuming a 10% IRR hurdle rate) for GHG abatement in the industrial sector from heat recovery from power generation and the optimization of pumps and compressors.

Vattenfall, a Swedish power company with a strong emphasis on addressing climate change, attempted to quantify the global potential for GHG abatement at costs of up to 40 euros per tonne of CO_2e by 2030.[2] Vattenfall (2007b) estimates that negative cost abatement opportunities constitute 35-45% of the total potential abatement in industrialized countries achievable for up to 40 euros per tonne. (see Figures 3-4 for details on Vattenfall's cost curves). The purported existence of such negative cost GHG abatement options (i.e. the "efficiency paradox") raises the question of how—given the neoclassical economic assumption of profit-maximizing firms—the invisible hand of the market has not pushed firms to already exploit such opportunities. Vattenfall (2007a) notes that its cost estimates consider only the cost of additional investments and changes in operating and maintenance costs minus energy savings and that there may be other transaction costs involved in making the studied investments; moreover, Vattenfall concedes that its cost estimates do not take into account changes in the perceived quality of the energy services (e.g. lighting) as a result of the GHG abatement projects.

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[1] The McKinsey study considers the transportation sector separately, so the commercial sector refers mainly to energy used in commercial buildings.

[2] 1 tonne of CO_2e refers to an amount of any GHG with a global warming potential equivalent to that of 1 tonne of CO_2.

Those who believe the “energy paradox” is of a significant magnitude point to various barriers to energy efficiency that could be overcome by changes in government policy, organizational behavior, and corporate strategy that would allow firms to make profitable investments in energy efficiency. Studies of energy efficiency outline at least four major barriers to the full realization of profitable investments in energy efficiency (van Soest and Bulte 2002, Russell 2005, Schleich and Gruber 2006, McKinsey Global Institute 2007, Vattenfall 2007c). First, misaligned incentives lead to under-investment in energy efficiency. Examples of misaligned incentives include those between landlords and tenants and between purchasers and operators of equipment. In the former case, owners of commercial buildings may be reluctant to invest in energy efficiency (e.g. building insulation, high efficiency lighting) if tenants will reap the energy savings. Within organizations, those responsible for purchasing equipment are often not those responsible for operating it. Purchasers may consider the higher up-front purchase costs of more energy-efficiency equipment prohibitive if the firm’s rules do not reward purchasers for lower operating costs due to energy savings. Within firms the treatment of energy costs in budgeting and cost allocation often leads to underinvestment in energy efficiency. If a firm allocates energy costs across departments as an overhead cost, no department will realize the full benefit of its investments in energy efficiency thus reducing the incentive of any individual department to pursue energy efficiency. Second, firms and managers may have limited knowledge of the potential for profitable energy savings, and acquiring this information is costly. Employees may not understand how their decisions affect energy usage. Even when a firm is aware of the possible benefits of energy efficiency, identifying and evaluating energy efficiency investments can be costly in terms of time and resources. Third, managers may depart from the typical assumption of rational profit-maximizing behavior and engage in behavior governed by bounded rationality. Bounded rationality refers to the use of rules-of-thumb or routines to make complex decisions in the face of limited time, resources, or information. RMI has demonstrated how the use of whole-system optimization in the design of buildings and factories can lead to enormous energy savings compared to designs based on applying rules-of-thumb to the selection of individual components (Lovins 2005). Finally, biases in capital budgeting may lead to underinvestment in energy efficiency from a profit-maximizing perspective. Managers may fail to employ the net present value (NPV) framework for capital budgeting and instead may rely on inferior methods such as payback period. Managers may be biased against positive NPV energy-efficiency projects and favor projects with shorter paybacks (but inferior NPV) because of managers' desire to capture full credit for successful projects during their limited tenures. Even if managers dispassionately apply NPV analysis in capital budgeting, they may miscalculate the NPV of energy efficiency investments if they discount cash flows using the firm's weighted average cost of capital in cases where the risk profile of the energy efficiency investment is significantly different than that of the firm's normal line of business. In addition, managers may be biased against cost-saving projects, such as energy efficiency investments, in favor of revenue-expanding projects owing to a perception that managers rise through the ranks more effectively by growing sales than by cutting costs.

There are few academic studies that rigorously evaluate the existence and magnitude of the aforementioned market barriers. In one such study, Schleich and Gruber (2006) analyzed data from interviews with nearly 2800 firms in the German commercial and services sector. The authors categorized firms as active or inactive on energy efficiency based on the percentage of feasible investments they had undertaken and asked representatives of the firms about perceived barriers to investing in energy efficiency. The authors employed a logit regression to determine if perceived barriers predicted whether firms where active or inactive with respect to energy efficiency. The statistical significance of the barriers varied across subsectors, but lack of information about energy efficiency and the landlord-tenant incentive misalignment for commercial office space were statistically significant in one-third and one-half of the sub-sectors, respectively. Schleich and Gruber do provide some empirical evidence for the existence of barriers to energy efficiency.

Some economists are skeptical of the existence of a sizeable "efficiency paradox" and thus of significant negative cost GHG abatement options. Sutherland (2000) offers a critique of the "efficiency paradox" which he sees as the result of engineering cost analyses that do not follow the methodology of economic cost-benefit analysis. According to the skeptics, estimates of negative cost energy efficiency investments ignore real transaction and adjustment costs associated with energy-saving projects, many of which may be difficult to observe or measure but real nonetheless. Moreover, skeptics argue that the market barriers that proponents of the "efficiency paradox" highlight are simply the normal adjustment mechanisms of free markets, which cannot be costlessly eliminated. Economists also criticize the claim that firms, in effect, use irrationally high hurdle rates in evaluating energy efficiency projects thus leaving profitable energy efficiency investments unrealized. Metcalf and Rosenthal (1995) apply modern investment theory to the evaluation of energy efficiency investments to properly take into account their irreversibility, uncertain returns, and flexibility of timing. Energy efficiency investments are largely irreversible since a firm often cannot resell installed equipment for a value near its cost (e.g. energy efficient lighting, insulation). Returns from energy efficiency investments are uncertain since firms face uncertainty both in future energy prices and the actual performance of new equipment. Energy efficiency investments are flexible insofar as firms can usually delay them without precluding their future adoption. Metcalf and Rosenthal show that, in theory, traditional discounted cash flow analysis that does not account for these factors will overstate the NPV of energy efficiency investments and thus lead to an overestimate of negative cost GHG abatement opportunities. van Soest and Bulte (2001) demonstrate that traditional financial evaluations of energy efficiency investments fail to take into account the option value firms sacrifice when they implement energy efficiency projects. van Soest and Bulte point out that technological advances are uncertain in both their timing and performance. This uncertainty means that firms derive an economic benefit in the form of an option value from delaying energy efficiency investments since new technologies (e.g. more efficient lighting or HVAC equipment) may enter the market after the firms have already committed to investing in subsequently inferior technologies.

Anecdotal evidence suggests that at least the most optimistic estimates of negative cost GHG abatement options do, in fact, ignore actual costs. In his profile of Auden Schendler, a former researcher at RMI and now the manager of "corporate sustainability" at Aspen Skiiing Co., Elgin (2007) describes some of the obstacles Schendler faced in trying to apply RMI's philosophy of negative cost energy efficiency investments. Schendler had difficulty finding energy efficiency projects that met the firm's IRR hurdles. In one example, Schendler proposed installing compact fluorescent lights in a high-end lodge only to have his proposal opposed by the lodge manager who felt that the quality of the new bulbs' light would detract from the lodge's ambiance and hurt sales—the sort of real but difficult to measure cost that skeptics claim is often overlooked in evaluating energy efficiency investments.

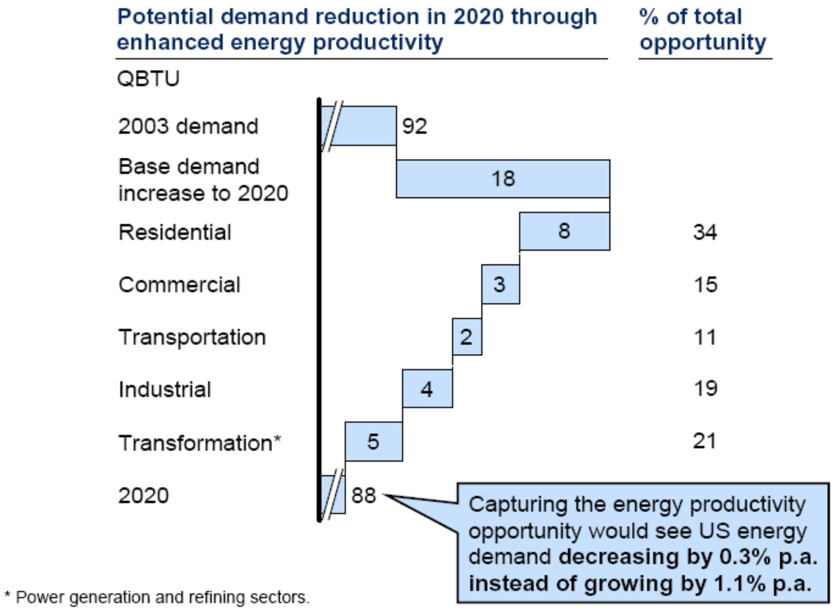
To the extent that negative cost GHG abatement opportunities do exist, what can firms do to exploit them? Case studies prepared by the Energy Efficiency and Renewable Energy Office

(EERE) of the US Department of Energy profile several leading US companies' successful corporate energy management programs. A review of case studies covering Alcoa North America Extrusions, 3M, Unilever Home and Personal Care, Kimberly Clark Corporation (KCC), Merck & Co., DuPont, and C&A Floor Coverings revealed a set of five common best practices for successfully exploiting energy efficiency opportunities. First, the firms in question created energy teams. Some firms created centralized corporate energy management teams with local stakeholders while others created energy management teams at individual locations. The International Organization for Standardization (ISO) recognizes a management system for energy (MSE 2005) which requires a team-based approach to energy management with members representing diverse functional areas. C&A Floor Coverings' experience implementing MSE 2005 highlighted the need for managers to collaborate outside their usual organizational-chart roles and hierarchy. Second, to exploit energy efficiency firms must institute appropriate performance tracking and accountability for energy usage. Merck, for example, made energy savings a standard metric for the manufacturing division's performance evaluation. Unilever created a centralized reporting process for energy usage across all facilities with easy comparison to baselines and goals. Alcoa appointed at least one person at each facility with ultimate accountability for energy usage. Third, firms must change corporate procedures to include a focus on energy usage and efficiency. For example, 3M's corporate energy management team developed a self-assessment checklist that its facilities could use to ensure they were properly addressing energy issues, such as by: conducting energy audits; forming energy teams with representatives from maintenance, production, and engineering; and identifying and prioritizing projects. DuPont instituted a requirement that new projects include an analysis of energy efficiency in order to gain approval. Fourth, firms need to foster energy efficiency information sharing. Many firms instituted electronic information sharing practices related to energy management and efficiency. Merck, 3M, KCC, DuPont, and Alcoa all created corporate intranet sites for disseminating energy efficiency information ranging from best practice checklists to databases of energy-saving projects. In particular, 3M created an online database of energy efficiency projects that plant managers could search based on technology, costs, rates of return, and other parameters. Alcoa started an energy alert program that emailed energy management stakeholders throughout the company when a facility reported a successful new energy efficiency project to rapidly and actively disseminate information. In addition to electronic information sharing, 3M and DuPont held once or twice yearly energy conferences to foster information sharing and innovative problem solving. Lastly, firms should maintain a corporate focus on energy efficiency. DuPont, for example, incorporated energy management and energy savings through efficiency as part of its corporate Six Sigma strategy. Unilever reported that its documentation of energy savings were critical to sustaining corporate interest in energy management. The best practices distilled from the EERE case studies provide examples of firms overcoming some of the barriers to energy efficiency described above. For instance, firms fostered information sharing to overcome the barrier of lack of information. The creation of energy management teams, the assignment of accountability for energy usage, and the adoption of new procedures and performance measurement standards addressed the barrier of misaligned incentives. While the best practices discussed above apply most directly to manufacturing firms, commercial sector firms can tailor some of the lessons to their own circumstances.

There are roles for the government to play in promoting the adoption of the least-cost (if not negative cost) GHG abatement options by firms in order to minimize the social cost of climate change mitigation. Government standards for equipment energy efficiency may be appropriate in some cases. Of more certain value are government programs that generate and disseminate information about energy efficiency. Since such information has public-good aspects, the private market will undersupply it. As such, government can promote social welfare by funding energy efficiency research and communicating information on energy efficiency, such as via demonstration projects and case studies.

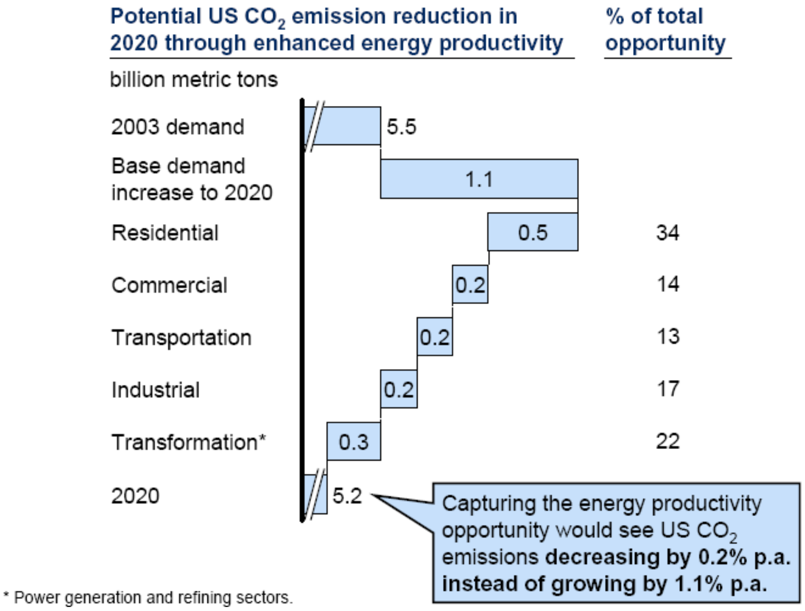
Recent prominent studies have reported sizeable estimates of negative cost GHG abatement opportunities due to the “efficiency paradox.” Believers in the “efficiency paradox” point to common barriers to the exploitation of profitable energy efficiency investments with at least some empirical support; however, skeptics have evidence that studies such as those by the McKinsey Global Institute and Vattenfall may inaccurately measure the costs and benefits of energy efficiency investments. Corporate executives should pay careful attention to the debate over the “efficiency paradox” in order to identify opportunities to increase shareholder value via energy efficiency, to adopt the appropriate energy management best practices, and to be sure their firms appropriately evaluate energy efficiency in capital budgeting. The question of negative cost GHG abatement options holds importance for policymakers since they must understand it if they are to know the true cost of climate change mitigation and they must be able to optimally promote energy efficiency if they are to achieve climate change mitigation cost-effectively.

Figure 1: McKinsey Estimates of Energy Productivity Improvements (IRR > 10%)



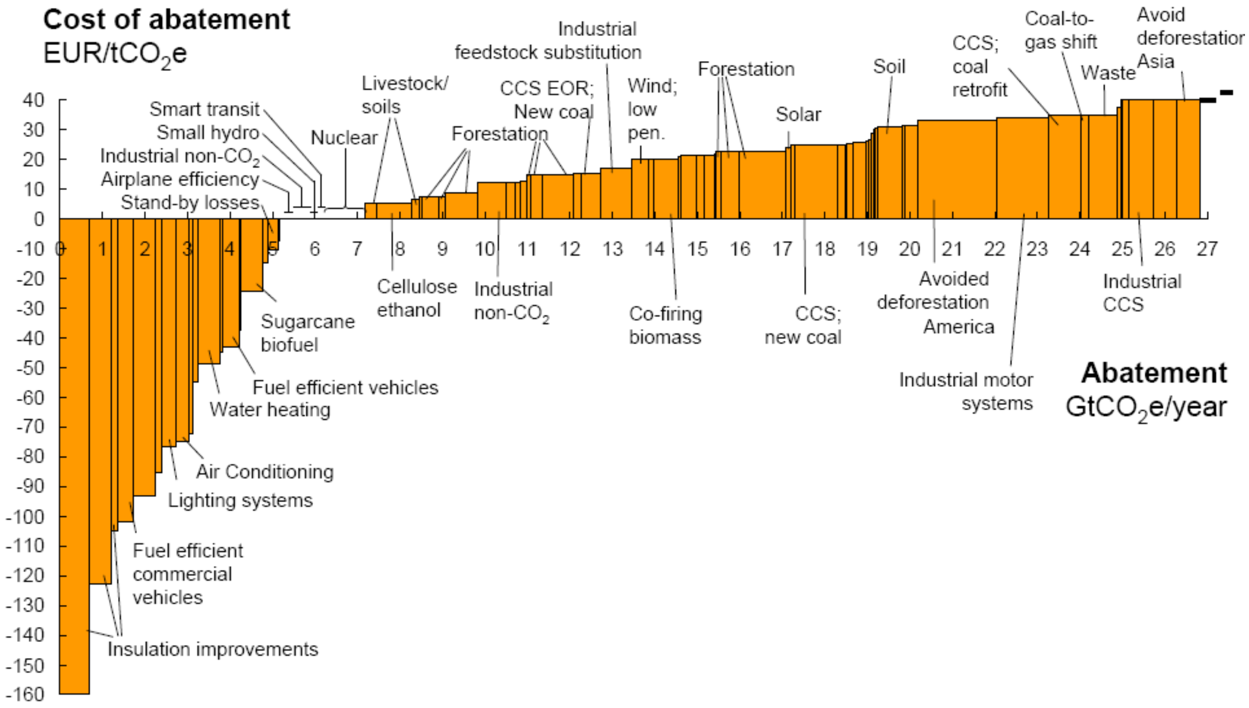
Source: McKinsey Global Institute (2007) p. 13

Figure 2: McKinsey Estimates of GHG Emissions Reductions (IRR > 10%)



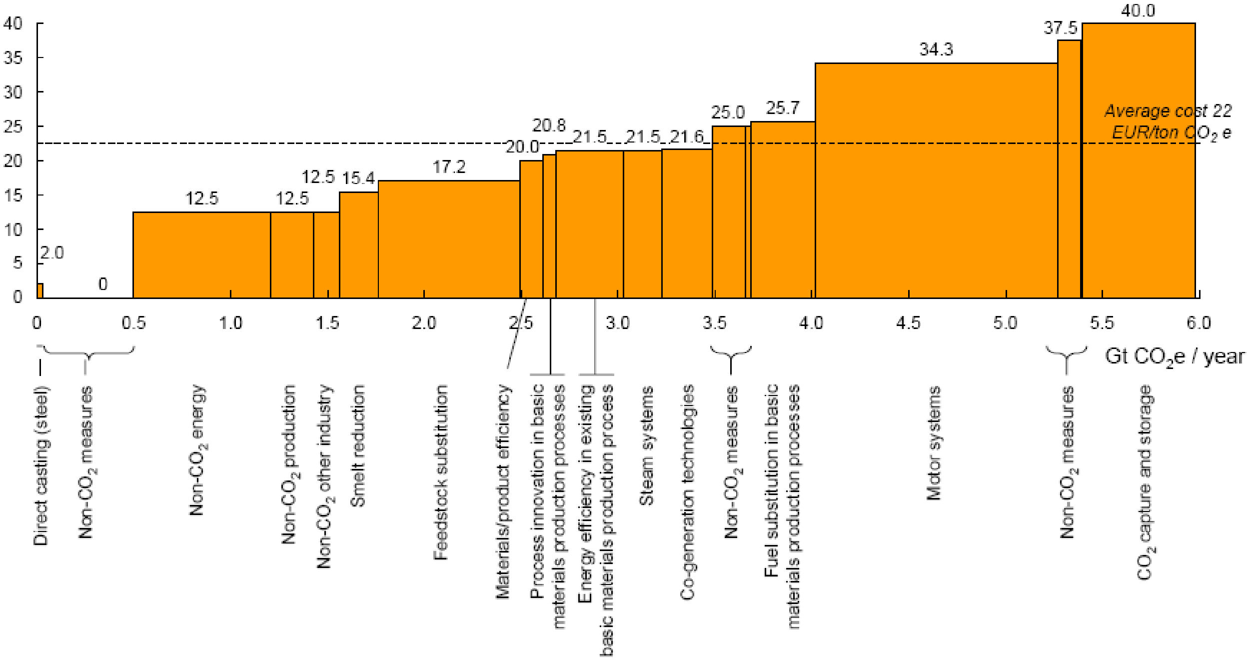
Source: McKinsey Global Institute (2007) p. 13

Figure 3: Vattenfall Climate Map GHG Abatement Cost Curve



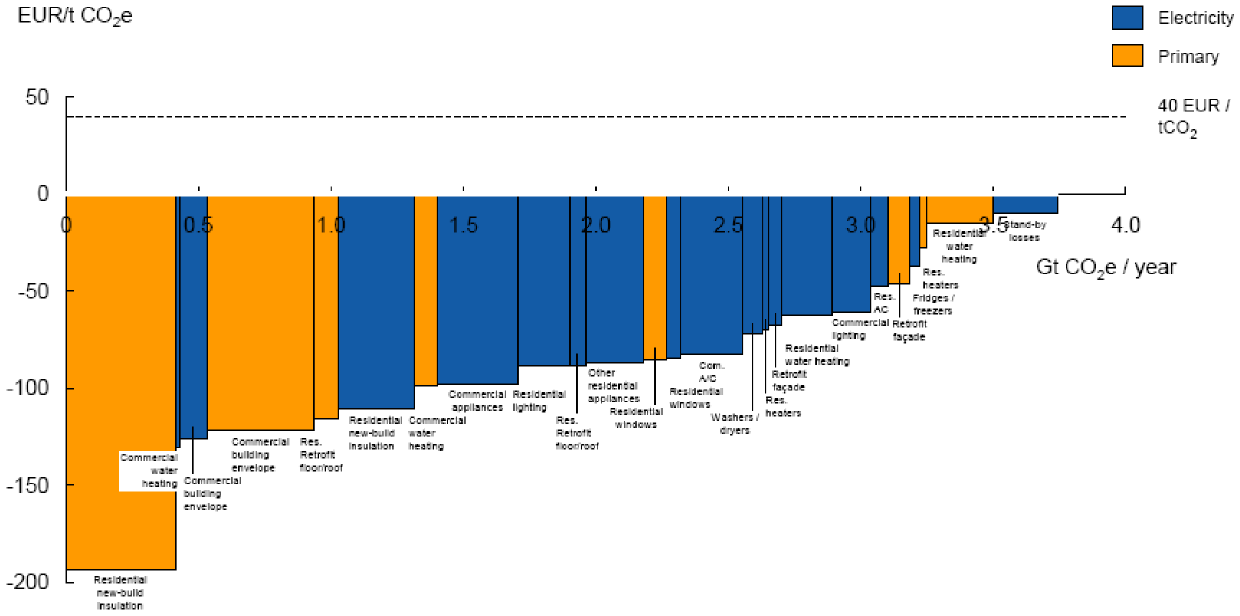
Source: Vattenfall (2007b) p. 7

Figure 4: Vattenfall Climate Map GHG Abatement Cost Curve for Industrial Sector



Source: Vattenfall (2007d) p. 8

Figure 5: Vattenfall Climate Map GHG Abatement Cost Curve for Buildings Sector[3]



Source: Vattenfall (2007c) p. 9

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[3] The buildings sector GHG abatement opportunities in the cost curve are (from left to right): residential new-build insulation (primary); commercial water heating (electricity); commercial building envelop (electricity); commercial building envelop (primary); residential retrofit floor/roof (primary); residential new-build insulation (electricity); commercial water heating (primary); commercial appliances; residential lighting; residential retrofit floor/roof (electricity); other residential appliances; residential windows (primary); residential windows (electricity); commercial A/C; washers/dryers; residential heaters; retrofit façade (electricity); residential water heating (electricity); commercial lighting; residential A/C; retrofit façade (primary); residential heaters, fridges/freezers; residential water heating (primary); stand-by losses.

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