Energy Efficiency – Should We Take It Seriously?

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Introduction

Energy efficiency is the motherhood and apple pie of the energy world. No-one has anything bad to say about it; it is supposed to be able to solve just about any problem. The European Commission, for instance, in its "Energy 2020" strategy document[1] states that:

"Energy efficiency is the most cost effective way to reduce emissions, improve energy security and competitiveness, make energy consumption more affordable for consumers as well as create employment, including in export industries."

The World Energy Council (WEC), in similar vein, suggests that:

"Energy efficiency is the winning strategy to simultaneously address a variety of policy objectives, including security of supply, climate change, competitiveness, balance of trade, reduced investment need and environmental protection"[2].

The International Energy Agency (IEA) agrees:

"Improvements in energy efficiency can reduce the need for investment in energy infrastructure, cut fuel costs, increase competitiveness and improve consumer welfare. Environmental benefits can also be achieved by the reduction of greenhouse gases emissions and local air pollution. Energy security can also profit from improved energy efficiency by decreasing the reliance on imported fossil fuels."[3]

It sees energy efficiency as particularly important in relation to climate change:

"Increasing energy efficiency, much of which can be achieved through low cost options, offers the greatest potential for reducing CO_2 emissions over the period to 2050. It should be the highest priority in the short term"[4].

British politicians are of the same mind. The web-site of Chris Huhne, Secretary of State for Energy and Climate Change, states that "Increasing energy efficiency is the key to reducing emissions" while Malcolm Wicks – then the Prime Minister's Special Representative on International Energy – claims that "energy efficiency must be the starting point [for increased energy security]"[5].

Best of all, perhaps is that energy efficiency is not just low cost but negative cost – not just a free lunch but a lunch you are paid to eat. The Commission comments that "above all, it provides tangible benefits to citizens: average energy savings for a household can amount to € 1 000 per year". Chris Huhne told Parliament that under the Green Deal, described as the Government's "flagship policy" "households could save up to £400 a year once the measures have been paid off. That will flow through to their spending power, boosting living standards for all."

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[1] COM(2010) 639 final
[2] In *Energy Efficiency: A Recipe for Success* World Energy Council, London 2010 (WEC 2010)
[3] IEA web-site energy efficiency page
[4] *Energy Technology Perspectives 2010* IEA Paris 2010
[5] *Energy Security* Department of Energy and Climate Change 2009

Against this background, it might seem churlish to raise questions and it is certainly not the intention of this note to argue against energy efficiency, which is clearly a desirable goal in itself. Rather the aim is to plead for a more balanced and judicious approach in which the role of energy efficiency in meeting energy policy goals can be assessed, and energy efficiency policies implemented, in a more considered and targeted manner. Only then, this note argues, will we be able to realise the benefits. At the moment, because there is an indiscriminate tendency to embrace energy efficiency in more or less any form for more or less any purpose, it is in fact probably delivering relatively little in the way of results and therefore actually impeding the achievement of energy policy objectives by diverting effort away from more effective measures and creating false expectations. It is only if we start taking energy efficiency seriously that it will have any serious impact.

Definitions

One significant obstacle to a clear view of the issue is that the use of the term energy efficiency is often somewhat loose, allowing commentators to slip between one meaning and another in support of their various claims. At least four quite different concepts are often elided in one way or another:

- **Technical Efficiency** The standard definition of energy efficiency is that it is essentially a form of productive efficiency. That is, in the words of the WEC, "Energy efficiency improvements refer to a reduction in the energy used for a given service (heating, lighting etc) or level of activity".[6] On its energy efficiency web-site the IEA gives a similar definition: "Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input." The basic concept here is clear enough. Nonetheless a number of questions remain – for instance, is the qualification "cost effective" understood to be part of the definition? It is not generally stated but seems to be implied – for instance, the various estimates of net present benefits and negative costs discussed in this paper rely on the assumption that the measures are intrinsically cost-effective. Most energy efficiency improvements arise from the substitution of capital for energy and presumably even the most ardent advocate of energy efficiency does not assume that **all** such substitutions are worthwhile, whatever the ratio of cost to saving – eg one would not spend £1 million in capital to save £1,000 per year in energy costs. Then there is the question of how the energy input is to be treated – in terms of final energy or primary energy? Should "embodied energy" be included? (Embodied energy is the energy used to make a product or piece of equipment – in the example quoted above, it is likely that the embodied energy in the £1 million of capital equipment would exceed the operational energy savings it produced, so that it would not even lead to a reduction in overall energy demand). Should the quality of energy be taken into account? Should we be thinking in terms of exergy (energy available for useful work) rather than energy? Perhaps most fundamental is the question of how energy services should be defined. Definitions commonly used (like passenger-kilometres or lumen-hours) may miss major aspects of the service concerned (time saved and comfort in relation to transport; lighting quality and responsiveness). So judging whether efficiency has increased, even at the technical level, is not a straightforward matter.

[6] WEC 2010

- **Energy intensity** This is a more economic perspective on efficiency. At country level, it normally refers to the ratio between output (GDP) and energy use. The IEA calculates it as the ratio of Total Primary Energy Supply, in millions of tonnes of oil equivalent (mtoe), to GDP expressed in dollars, either in current or Purchasing Power Parity terms. The same sort of intensity ratio can be used for the output of a given industry sector. In both cases the problem is obvious: that in addition to the technical efficiencies described above, this definition brings in other factors to do with the structure of the economy (how large a share of GDP is accounted for by manufacturing industry, which tends to be relatively energy intensive, for instance) or of the sector's output (for instance, the balance between basic steel production and specialist high grade products). It would be perfectly possible, depending on the sector and country, to score well in terms of technical efficiency but badly in terms of intensity (or vice versa).
- **Demand response** Demand response (DR) is sometimes used as a general expression to cover all sorts of change in demand. More commonly, however, it is used more narrowly to refer to changes in the pattern of usage designed to lower system costs. The US Department of Energy for instance, defines it as "Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardised"[7]. This definition may be too narrow – interruptible gas contracts for instance could be regarded as an analogous instrument for promoting demand response – but the underlying concept is clear, and distinct from the technical efficiency referred to above. Demand response is about changing the patterns and timing of demand in the interests of system management rather than improving the efficiency of provision of a specific energy service.
- **Energy conservation (demand reduction)** During the 1970s the term "energy conservation" was generally used, not "energy efficiency". The aim of conservation was clear - to reduce energy demand (at the time the main concern was over the shortage of energy resources). But demand reduction is not necessarily a matter of efficiency – the most obvious routes are either higher energy prices or regulatory restrictions on energy use, which might have little to do with technical efficiency while, as we will see, energy efficiency does not necessarily reduce demand. The term "energy efficiency" (rather than conservation) came into favour during the 1980s as resource concerns declined and economic efficiency took greater prominence. At the time it was distinguished from the previous conservation efforts – such as the "Save It" campaign – precisely because it was not aimed at reducing demand as such. The present position is somewhat anomalous. We seem to be stuck with the term "energy efficiency", as in the examples above, but the aim is once again to achieve demand reductions (though now primarily for environmental rather than resource reasons).
- A further additional cause of confusion is that governments sometimes use the term "energy efficiency" to refer to their energy efficiency **policies and measures.** While clearly the two areas ought to be related, they are distinct and do not necessarily have the same impacts – just as, say, policies to stimulate economic growth are not quite the same thing as economic growth itself.

[7] USDOE *Benefits of demand response in electricity markets* Washington 2006

This paper is mainly concerned with the relationship between energy efficiency (or improvements in intensity) on the one hand, and reduction in energy demand on the other, since this is the rationale of the relevant government policies. It is clear that to achieve an increase in energy security or a reduction in emissions, an absolute reduction in energy demand, or at least a reduction compared with a business-as-usual baseline, must take place; if efficiency simply leads to a higher consumption of energy services with no net reduction in energy requirements it will not advance the emissions or security objectives. On the other hand, it is also clear that if efficiency is to be a low cost route, then it must indeed be both genuinely cost-effective and an improvement in technical efficiency.

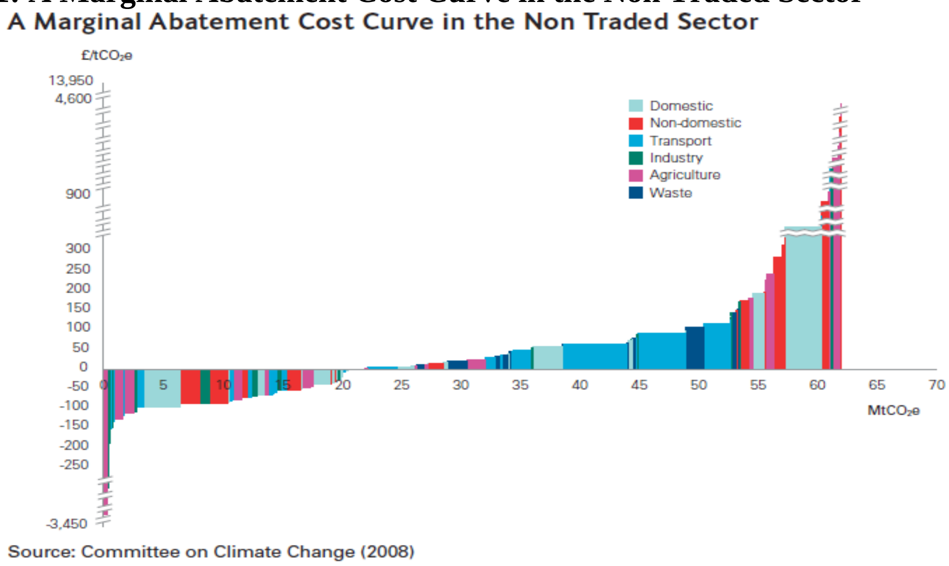
In addition, the concern of this note is mainly with policies – how they can be made more effective – rather than with energy efficiency in general, though in practice much of the theoretical discussion below focuses on the general concept, while the practical measurement issues relate mainly to policies. The paper does not deal with DR in the narrower senses defined above. DR is likely to be an important feature of any future energy system (indeed much more important than today, as the penetration of intermittent, unpredictable sources increases, the cost of coordinating and aggregating demand side response goes down, and new energy demands, like electric vehicle use are added to the mix). However, the benefits lie in improving demand side flexibility and responsiveness; DR has little to do with energy efficiency policies as they are generally understood at present.

Finally, the note does not deal with efficiency in upstream energy conversion (eg higher power station efficiency), which also generally lies outside normal political definitions and to which somewhat different arguments apply.

Cost Effectiveness

As the quotations above indicate, governments see major cost advantages in energy efficiency over other routes to emissions reduction. Their calculations tend to be based on analyses like those underlying the cost curve below:

Figure 1: A Marginal Abatement Cost Curve in the Non Traded Sector

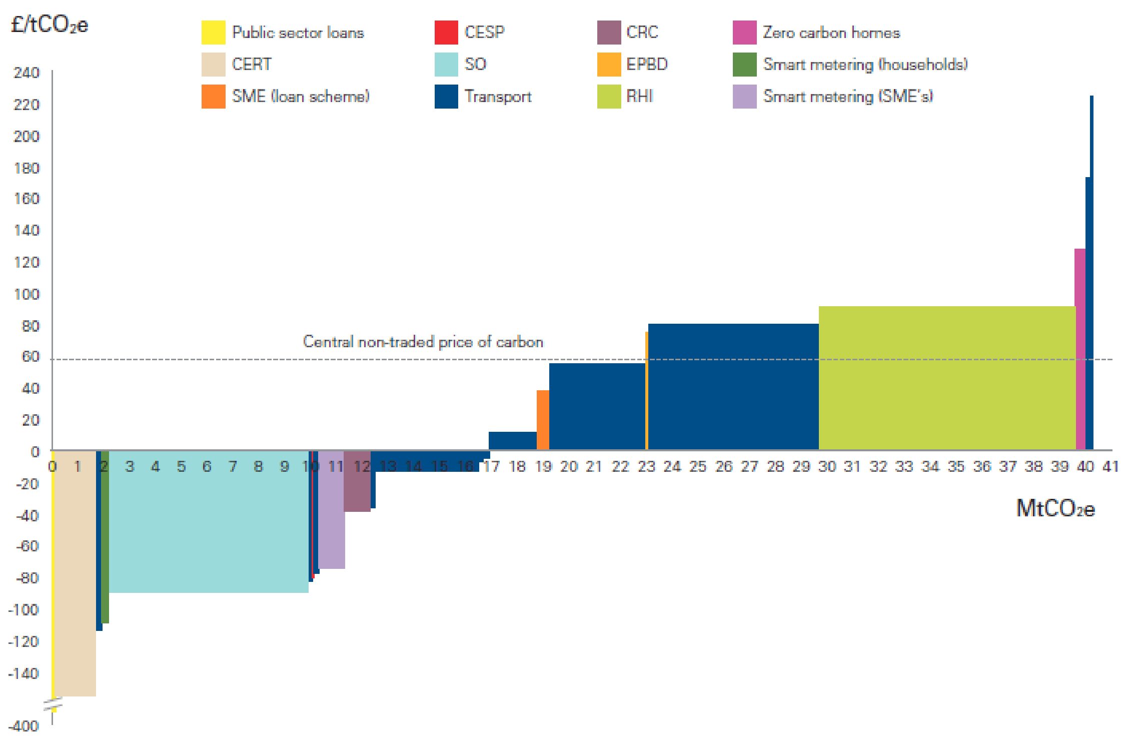


This sort of cost curve, popularised by the consultancy firm McKinsey and Company, looks at the cost and potential of various measures for CO_2 emissions abatement. The width of each bar shows the size of the potential for each measure; the height of each bar shows the cost (in this case, a cost curve produced by the UK Committee on Climate Change, in £s per tonne of CO_2 abated), which has generally been estimated on the basis of ex ante engineering calculations. Those bars which extend below the X-axis have negative costs – in some cases very high negative costs – that is, the benefits of the measures, even before taking account of the emissions savings, far exceed the costs. Typically about 30-40% of the reduction potential shown on such abatement cost graphs is negative cost, and most of this is energy efficiency.

The UK government has used such calculations to produce what is called a “Policy MAC”; the general idea is similar but here it is the impact of policies, rather than of particular measures, which is being represented, as in the example below, which was part of the previous Administration’s low carbon strategy. Again it can be seen that nearly 40% of the measures, mainly energy efficiency, are shown as negative cost. When the more expensive energy efficiency measures above the X-axis are included, efficiency emerges as far and away the most important single policy instrument in the so-called “non-traded” sector (that is, excluding industrial sector measures such as carbon trading – which may of course involve a significant energy efficiency component too – and electricity renewables obligations):

Figure 2: Policy MAC Curve for Policies that Deliver Savings in the Non-Traded Sector

Policy MAC curve for policies that deliver savings in the non-traded sector



Source: Department of Energy and Climate Change (2009)

It can be seen that the bulk of the expected negative cost outcomes are accounted for by two programmes, CERT and SO – the Carbon Emissions Reduction Target and its replacement, the Supplier Obligation. (Broadly comparable programmes are being introduced under the present Administration). The UK Low Carbon Transition Plan of the previous Administration puts the net present benefit of these two main energy efficiency delivery programmes at over £30 billion, even before the CO_2 savings are taken into account[8] . The cost of the programmes is also high – the government puts the cost to suppliers of the CERT programme at £5.5 billion over its lifetime or more than £1 billion per year, and the net benefits come after these costs are taken into account. The benefits therefore amount to a staggeringly large sum and prompt the question: if such benefits are available and cost-effective, why is no-one taking them up anyway (and why not pursue them, even without the need for carbon emissions reduction)?

The traditional answer to this is that there are various market barriers and failures in the energy sector which prevent the savings from being realised. Different authorities give different versions of exactly what these failures are supposed to be; the list below is drawn from a recent authoritative survey of electricity demand[9] though the commentary is this author's:

- **Environmental externalities** These are indeed a genuine market failure – the failure to internalise the costs of greenhouse gas emissions being the greatest market failure of all time according to Nicholas Stern[10] - and would on their own justify government intervention. However, that intervention would in principle consist of a carbon tax to internalise the externality, rather than efficiency programmes, and the carbon externality does not, of course, account for the (pre-carbon) benefits ascribed to energy efficiency.
- **Imperfect information** The claim here is that consumers lack information about energy efficiency, preventing them from making rational decisions. There is no doubt some truth in this but governments have moved significantly to make good the deficiency. Efficiency figures for vehicles (mpg data), household appliances (energy labelling) and houses themselves (Environmental Performance Certificates) are now required, and standards are imposed on these areas of energy use in one form or another, covering the majority of residential energy consumption. It is difficult to believe that the remaining barriers are hugely significant.
- **Absence of markets** The idea here, extending the previous point, is that comparisons are made more difficult by the fact that there is no market for energy efficiency as such. If a consumer could enter a supermarket where both energy (at say 10p/kWh) and energy efficiency (at say 5p/kWh saved) were on display they would naturally go for the latter. But markets do not work this way; energy efficiency comes packaged up in a product, making the comparison difficult, so energy efficiency opportunities are missed. Once again it seems likely that this argument is significantly overstated – first, because of the regulated efficiency standards which fill much of the gap; second, because markets can and will be created if there is underlying demand. It has often for instance been noted that as long ago as the 18th century James Watt and Matthew

[8] *The UK Low Carbon Transition Plan Analytic Annex* Chapter 4. HM Government 2009
[9] Jamasb T. and Pollitt M. *The Future of Electricity Demand* Cambridge University Press 2011. Chapter 14 (Haney A. et al) deals with demand -side management.
[10] Stern, N. (2006). Review on *The Economics of Climate Change* . HM Treasury, London.

Boulton, in selling their improved steam engine, did so essentially by selling its energy efficiency – that is, by charging a premium to users equal to one third of the saving in fuel costs compared to an atmospheric engine. Similarly Energy Services Companies and Energy Performance Contractors have an incentive to fill any gaps and help exploit energy efficiency opportunities which markets may otherwise not promote effectively.

- **Split incentives** This refers to situations where the costs and savings relating to an energy efficiency scheme are split between a number of parties so that no individual party has a clear incentive to undertake the project. The classic example is the landlord/tenant relationship. Here the landlord is normally responsible for the fabric of the building and would bear the cost of an energy efficiency upgrade, while the tenants would receive the benefit, in terms of lower energy bills and higher comfort, but only for as long as they remain in the building. But once again it is difficult to see that this is a fundamental problem – if it were, the quality of rented property would be a national scandal. In practice landlords can and do improve their properties, in order to attract a higher rent, while residual health and environmental problems are dealt with via buildings regulations.
- **Capital constraints** Energy efficiency measures normally involve the substitution of capital for energy so consumers facing capital constraints may be unwilling to undertake the measures. Once again it is difficult to see this as a major issue, except for low income consumers, who may indeed need help. Most "big ticket" consumer spending is subject to capital constraints and loans are likely to be more easily available for cost-saving investments than for, say, holidays, so it is not clear that capital constraints are a market failure in relation to energy efficiency. It is more likely that the unwillingness of consumers to invest capital in energy efficiency is a product of the three factors listed below.
- **"Bounded rationality", low priority for energy efficiency and risk aversion** This is a set of reasons given to explain why consumers invest less in energy efficiency than experts think they would if they were behaving rationally. The difficulty here is that consumers may genuinely see things differently – they may see risks of which the experts are not aware; they may have different preferences and priorities or may face different constraints from the experts. Ignoring these factors may lead to an incorrect calculation of costs and benefits on the part of the experts who are not familiar with the particular consumer's situation.
- **Transaction costs** These are indeed a disincentive to many energy efficiency measures but it is difficult to see them as an artificial barrier or market failure. Transaction costs are not just ubiquitous but they may well be instrumental in framing the whole shape of our economy – the very existence of firms rather than individuals as dominant actors arises in large part from the need to reduce transaction costs according to Coase's analysis of *The Nature of the Firm*. Furthermore, the distinction between "transaction costs" and the "hidden costs" discussed below is not always clear. These may all simply be real costs ignored by the expert analyses.

Hidden Costs

In general, therefore, it is difficult to see that market failures in the narrow sense have an impact on the scale of the £30 billion cited above, especially given that governments have already taken action to offset the main such barriers. It may be that the wider issues listed – effectively consumer apathy about energy efficiency – lead to what is assessed as sub-optimal behaviour, but even that is by no means clear given that there may well be significant costs which are not taken into account in the calculations which underlie the curves shown above. Indeed, DECC has noted that:

"There are real and substantial time and financial costs associated with domestic energy efficiency and carbon saving measures that existing cost-effectiveness analysis neglects"[11]

The comment was based on a study by the consultants ECOFYS[12] which looked at the private costs associated with energy efficiency measures – time, inconvenience and the like – and concluded that they could in some cases be very large. In the case of internal solid wall insulation, for instance, the payback period comes out at six years when the hidden costs are not included, which is a reasonably attractive investment; when hidden costs are included, the payback period is anywhere between 28 and 46 years, an extremely unattractive investment. This is admittedly an extreme example and inevitably dependent on the methodology of the particular study concerned. Nonetheless, it should give pause for thought – the calculations underlying the cost curves on which governments rely may not be as definitive and rational as is implied; different approaches could give quite different results. While consumers may indeed lack expert knowledge it is also true that experts probably have no clear understanding of the situation of many consumers or the full range of costs they face.

The conclusion of the above discussion is not that policy measures to promote energy efficiency are unjustified – there are indeed residual barriers plus one major market failure in relation to environmental externalities. While in principle the "correct" solution to this problem is to incorporate the externalities in the energy price, it may be politically impossible to do so; furthermore, the urgency of responding to climate change and the clear evidence of a sort of consumer apathy may justify measures to accelerate progress in this area, in addition to the strong argument for special help to low income consumers on both social and environmental grounds. What does seem clear, however, is that the supposed cost-effectiveness of such measures needs to be viewed with considerable scepticism and therefore that any interventions need to be examined critically, and their impacts monitored rigorously, to ensure that they are justified in terms of energy policy, environmental or social goals and actually achieving the desired results.

The Impact on Demand

In particular, except in the case of social measures, it is important to establish that the interventions will actually reduce energy demand. At first sight this might seem an obvious result – using less energy to produce a given level of services must mean what it says, ie using less energy. But in fact this result is not obvious and has indeed been highly contested. It might be helpful to consider the analogy of labour efficiency (ie higher productivity). The Luddites used to argue that the introduction of more efficient machines, and the consequent higher labour productivity, would reduce demand for labour. But few would accept this argument today – politicians routinely argue the reverse: that increased productivity will stimulate competitiveness and growth and thus increase demand for labour. Yet the same politicians seem happy to argue the opposite in relation to energy – they base their policies round the assumption that improving energy efficiency reduces, rather than increases,

[11] DECC 2009 p 43, referring to a study by ECOFYS.

[12] *The hidden costs and benefits of domestic energy efficiency and carbon saving measure* ECOFYS, May 2009

demand for energy. In fact, in both cases, labour and energy, the position is very much more complex than either simple mantra implies. There is a considerable literature on the topic in relation to energy, some of which is discussed below. A good introduction can be found in the special issues of *Energy Policy* magazine (vol 28, no 6-7, June 2000) and the rather more sceptical *Energy and Environment* (vol 11 no5, 2000).

The starting point is the Jevons paradox, named after the 19th century economist William Stanley Jevons, who argued in 1865 in his book on *The Coal Question* that technological progress that increases the efficiency with which a resource is used tends to increase rather than decrease the rate of consumption of that resource. He stated that "It is a confusion of ideas to suppose that the economical use of fuel is equivalent to diminished consumption. The very contrary is the truth." Not all Jevons' forecasts have stood the test of time – his comment came in the context of worries about the depletion of the UK's coal resources, and the impact on the UK's paramount economic position – but the underlying principle remains important. It has been brought up to date, first in the so-called Khazzoom-Brookes postulate, developed (independently) by two economists on either side of the Atlantic in around 1980. The argument is essentially the same as Jevons' – that energy efficiency improvements will lead to substitution and income effects which will tend to increase demand. That is, energy efficiency is essentially the same as lowering the cost of energy services. It will therefore tend to increase demand for such services and the substitution of energy for other factors. In addition, if the cost of energy services goes down, the consumer has more money available for other expenditure, which will inevitably have at least some energy component, since energy underlies all the goods and services in our economy. (As noted above, there will also normally be an energy component in the energy efficiency equipment itself, which needs to be offset against the future savings). There has been extensive discussion in the literature of whether and in what circumstances these factors offset the initial efficiency reductions (for instance, if demand for some energy service is "mature" – ie we already have as much of it as we need – it will not increase just because the service is provided more efficiently).

A useful overview was given in the *Energy Policy* issue referred to above by Greening, Greene and Difiglio[13]. They identify four categories: direct and indirect rebound effects (the income and substitution effects referred to above), wider economic effects (as the economy reaches a new equilibrium at lower energy service costs) and transformational effects as energy efficiency changes consumer preferences, alters social institutions and rearranges the organisation of production. The wider economic and transformational effects are of course extremely difficult to measure or predict but there is ample evidence that, as they point out, "improvements in fuel efficiency have altered and could continue to alter human activity". Examples might be such technological advances as refrigeration. Services which used in the past not to be energy services as such came to be so when the technology advanced sufficiently to become economic; once this happened it resulted in major changes in individual and social life with consequent effects, among other things, on energy use. Given all these complications it is not obvious what the overall impact of energy efficiency will be.

At the core of the issue is a "boundary problem". That is, the answer to the question of whether energy efficiency leads to lower demand may well depend on what the boundary is for the analysis and, in particular, whether the wider economic and transformational effects

[13] *Energy Policy 28 (2000)* 389-401

are taken into account. Some examples may help to illustrate the nature of the complications. The first is that of international shipping, which has been identified by some analysts as a serious potential problem area in terms of emissions reductions. Because of its international nature, it falls outside national emissions targets and hence may not be subject to the same pressure to reduce carbon emissions as other sectors. Yet it has grown fast over recent years and is expected to go on doing so. The growth in shipping has been part of the phenomenon of globalisation – since the 1950s, for instance, the growth of international trade has consistently run at about twice the rate of economic activity as a whole and this is expected to continue. Furthermore, opportunities for fuel-switching are limited. The result is that on a "business as usual" scenario, the IMO suggests that international shipping could account to as much as 18% of manmade CO_2 emissions by 2050[14] if other sectors make efforts to reach global targets but shipping is unaffected. Yet, according to the IMO, technology is available to produce efficiency gains of 25 to 75%, with a corresponding reduction in the rate of emissions. Many of the measures are cost-effective.

The question is where to draw the boundary for analysing the ultimate impact on emissions of such efficiency savings. If we just look at a given set of ships and assume that they introduce more efficient technology but do not travel significantly greater distances as a result of the efficiency gains, we may be able to identify reductions. But if we look more widely at shipping in general, the reduction in costs is likely to promote an increase in activity as new international trade opportunities open up (and hence the building of new ships, more shipping between distant parts of the world etc). This may tend to increase rather than reduce emissions. Shipping efficiencies have in fact increased significantly over recent decades (as a result of technical improvements and containerisation) but this has gone hand in hand with growth in energy demand and emissions. The IEA estimates that international marine emissions have gone up by around two-thirds since 1990[15] and other estimates are even higher. So the impact of further efficiency gains could easily be an increase in emissions. Going one stage wider again, the reduction in shipping costs and growth in shipping activity might well have the effect of increasing global growth and the "delocalisation" of industrial activity – in particular from the OECD to non-OECD countries like India and China, where production is more energy and carbon-intensive. While a number of factors are involved in such delocalisation, it is likely that the effect would be accelerated by shipping efficiency gains, and the result would be higher rather than lower emissions. (Again, this is not just a theoretical example and would reflect what has in fact happened over the past few decades – the growth in international shipping stimulated by a reduction in costs has been one of the causes of globalisation, and the overall result has been increased emissions at a global level.)

Another example of the boundary problem in relation to energy efficiency is that of air conditioning as it developed in the United States last century. The efficiency of the air conditioning equipment itself increased steadily and costs decreased, making air conditioning a viable option for ordinary households. For each individual piece of equipment there was of course an improvement in efficiency. But for air conditioning service provision as a whole, there was a vast increase in energy demand as the number of installations grew exponentially. At a wider level, there was actually a reduction in housing fabric efficiency – air conditioning made possible the construction of cheap, lightweight housing with large picture windows in

[14] International Maritime Organisation *Second IMO GHG Study*. IMO April 2009

[15] IEA *CO_2 emissions from fuel combustion 2011* Table II.19

place of the thick-walled, small-windowed houses which had previously been the only way of making many hot areas habitable, so further increasing underlying energy demand[16]. Going wider again, the availability of cheap, comfortable housing in the South and South West of the United States encouraged internal migration to these areas from the more densely occupied (and therefore generally lower energy) cities of the North East and Mid West. So the ultimate impact has been a huge increase, not a reduction, in US energy use. Of course, as with shipping, many factors have been involved in the process and isolating the impact of greater energy efficiency is not easy; nonetheless, efficiency has undoubtedly been one of the factors.

The examples illustrate that the result of any assessment of the impact of energy efficiency on emissions is likely to depend on the boundaries for analysis. The wider they are drawn, the more likely that the analysis will show emissions increases rather than reductions – and of course the only figures which matter from an environmental perspective are the global ones. It is of course extremely difficult to estimate these wider effects, so they are often left out; however, an analysis which simply ignores them is not going to give an accurate picture.

Historical Evidence

Given that many of the wider effects are long term in nature and difficult to measure in advance, the first place to look for evidence is the historical record. There are relatively few analyses of long term energy trends (ie over centuries) – the reasons for this have been discussed in the author's earlier paper *Energy: The Long View*[17] and readers interested in the issue are referred in particular to the works of Vaclav Smil and Roger Fouquet[18]. What these studies show is that enormous increases in demand for energy can go along with similarly enormous increases in energy efficiency. For instance, it has been estimated by Fouquet and Pearson (2005) that since 1750, each person uses on average:

- 50 times more power;
- 250 times more passenger kilometres; and
- 40,000 times more lighting.

This has happened along with similarly huge increases in energy efficiency in the provision of these services, of the order:

- 100 times for power;
- 20,000 times for transport; and
- 1,000 times for lighting.

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[16] See the discussion in chapter 2 of Sioshansi F. ed *Smart Grid* Elsevier 2012 (Sioshansi 2012)
[17] Available on the OIES web-site
[18] For example Smil's *Energy in World History* Westview Press 1994, *Energy at the Crossroads* MIT 2005, *Energy in Nature and Society* MIT 2008, and *Energy Transitions* Praeger 2010; Fouquet *Heat, Power and Light* Edward Elgar 2008; Fouquet and Pearson 1998. A Thousand Years of Energy Use in the United Kingdom. *The Energy Journal*. 19(4): 1–41 and 2005. Long Run Trends in Energy Services, 1300-2000. In *Proceedings of Environmental and Resource Economists 3rd World Congress*. Kyoto, January 2005.

As these figures indicate:

- First, in many cases there is no obvious cap on the demand for energy services – it would no doubt have been impossible for an 18th century citizen to conceive that anyone could want 40,000 times more lighting than he or she enjoyed. Nonetheless, it has happened. We should be very wary of setting any a priori cap on potential service demand based simply on our own experience.
- Second, there is no obvious relationship between the efficiency increases and the demand increases – that is, in some cases efficiency will restrain demand growth, while in others it will increase it.

This is consistent with the general conclusions reached by these researchers. Smil, for instance concludes that:

"Historical evidence is thus replete with examples demonstrating that substantial gains in …. efficiencies stimulated increases of fuel ….use that were far higher than the savings"[19]

Fouquet reaches a similar conclusion:

"Dramatic declines in energy service prices certainly lead to rising service consumption and often energy use."[20]

An interesting variation on this conclusion comes from two studies looking over decades rather than centuries. Pollitt and Platchkov state that:

"A basic conclusion of the observation of a stable long-run relationship between energy demand and price and income is that the share of income spent on energy services is roughly constant".[21]

The WEC has reached a similar conclusion:

"Energy efficiency improvements appear to have been 'captured' by consumers to increase their well-being but not to reduce their energy consumption, as if consumers were keeping their energy budgets as a constant share of their spending, whatever the final energy price".[22]

The implication of the first two of these conclusions is that energy efficiency measures should be discriminating and effectively targeted – "energy efficiency" in a general sense is as likely to increase demand as reduce it. The implication of the second set of observations is that the simplest and most effective instrument for energy demand reduction is likely to be a carbon or other energy tax rather than energy efficiency. This may still leave room for well-targeted energy efficiency measures if they can be shown to be both low cost and effective in reducing demand. So it is worth looking at the evidence for demand reduction from energy efficiency.

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[19] Smil 2005 p 335
[20] Fouquet 2008 p 380
[21] In Jamasb and Pollitt 2011
[22] *Drivers of the Energy Scene* 2003 available on the WEC website.

Energy Intensity Improvements

One common measure of the demand impact can be dismissed relatively quickly – the argument from improved energy intensity. One example of this is given in the WEC document referenced earlier which states:

"Energy productivity improvements in most regions resulted in large energy and CO_2 emissions savings. At 1990 energy intensity …. world energy consumption would have been 3.6 Gtoe higher in 2008. In other words "energy savings" reached 3.6 Gtoe …or almost 30% of the primary consumption… This avoided 8 GT of CO_2 emissions".[23]

This is an odd claim. It refers to a period when energy demand nearly doubled and CO_2 emissions rose by roughly one half. This sort of "saving" is clearly not the route to a low carbon world. In any event, there is no particular reason to believe that a world where there is economic development but no improvement in energy intensity is a meaningful baseline. Such a world would have experienced no capital stock replacement, no structural change in industry – in short no growth. One way of looking at it is again to consider the labour productivity analogy – if someone were to suggest that the problem of unemployment could be dealt with by returning to 1970 levels of productivity, the argument would no doubt get short shrift – at those low productivity levels industry would be uncompetitive; output, incomes and employment would all (or in some combination) be lower rather than higher. So it is not plausible to say that the growth in productivity has reduced demand for labour proportionately. Similarly with energy, it is over-simplistic to say that the improvement in intensity has reduced demand; on the contrary it is clear that overall economic growth, the more efficient use of energy, and increases in energy demand go hand in hand. Indeed, in a survey of the links between these factors, a major UKERC report tends to side with those who believe that "when energy quality is taken into account the causation appears to run from energy consumption to GDP"[24] – that is, increased use of energy and increased efficiency of energy services are themselves a significant cause of economic growth. In any event, whatever the precise nature of the linkage, it is clear that a simple intensity based comparison is of little significance.

Consider, for instance, the following table:

Table 1: Energy demand and intensity comparisons

	Population (m)	TPES/GDP (toe/$,000)	TPES/cap (toe/person)	TPES (Mtoe)
Ethiopia	82.83	1.97	0.39	33
Switzerland	7.80	0.09	3.45	27

[23] WEC 2010 p 14
[24] Sorrell S. *The Rebound Effect* UKERC 2007

The two countries concerned have been selected because they are in almost all respects opposites – one very poor and underdeveloped; one very rich and with what might be called a post industrial economy. Switzerland has a population under one tenth that of Ethiopia. Despite that its national energy consumption comes out at roughly the same, around 30 Mtoe. This reflects a combination of much lower energy intensity in Switzerland (less than one twentieth that of Ethiopia) and much higher energy consumption per head (roughly ten times that of Ethiopia). Would anyone suggest that if Switzerland had the same energy intensity as Ethiopia its energy consumption would be 20 times higher, so that it has somehow "saved" nearly 600 Mtoe? Of course not; Switzerland would not be Switzerland if it had such high energy intensity. It is clear that the same underlying factor explains why Switzerland's energy intensity is lower, but energy consumption higher – that it is a more developed country, and therefore has richer inhabitants and higher output (hence higher consumption), along with a service oriented economy and more capital stock (hence higher efficiencies). It makes little sense to separate out just one of these factors. So measures of "savings" based on top-down measures of energy intensity mean very little in practice.

Measuring the Impact of Energy Efficiency Programmes

What about bottom-up savings measures? Governments are constantly producing estimates of savings from their existing programmes and projections of the savings from its future programmes. Do these have a firmer basis? The first thing that should be said is that even if the direct programme impacts are measurable, it is almost impossible to track the savings at national level – and it is of course at this level that emissions targets operate. In essence the problem remains that identified some years ago by the Environmental Audit Committee, which commented that

"In dealing with energy efficiency, there is a sensation of standing on shifting sands due to the difficulty of producing reliable future forecasts and evaluating the impact of current policy measures."[25]

Unless there is a clearly established counterfactual baseline it is not possible to identify the "savings" from energy efficiency measures with any precision. So many other things are changing – energy prices, technologies, economic growth outcomes, weather, consumer behaviour, development of new energy services and so on – that distinguishing the impact of energy efficiency measures in the outcomes requires, but does not usually receive, rigorous analysis. There is a considerable risk of falling into the "fallacy of composition", that is of taking one part of the system, on the basis that it is relatively easy to measure, then assuming that the rest of the system remains unchanged or that what is true of that part can be extrapolated to the whole. (In other words, the boundary problem associated with a micro-level analysis means that it fails to reflect macro-level impacts as discussed above).

Even at the micro level, there are significant measurement problems. There are many reasons why energy efficiency interventions may not deliver the expected results. The outcomes of interventions in domestic housing, such as insulation, depend on individual circumstances (the specific nature of the housing, its orientation, ventilation, existing insulation levels and so on), behavioural factors (how long the house is occupied, the heating patterns, whether the

[25] Select Committee on Environmental Audit 10th Report. House of Commons 2004

occupants respond to the new insulation by improving comfort levels and so on), technical factors (how effectively the insulation is installed, for instance) and all the wider issues mentioned above, which may in any event be changing energy consumption patterns. Ex ante engineering calculations cannot take account of all these individual complications, much less the wider economic feedbacks.

In addition, there is a number of specific issues which may be affecting the outcomes as compared with the theoretical calculations. These include:

- **Rebound effects** The many direct and indirect rebound effects discussed above. Engineering calculations are in some cases adjusted to take account of direct rebounds but usually ignore indirect rebounds, wider economy effects and (negative) transformational effects. Sometimes, on the other hand, the calculations include positive feedbacks such as "spillover", "uplift" or "market transformation" whereby the measures forming a direct part of the programme have a wider impact in encouraging the availability of, and interest in, the more efficient technology or measure.
- **Persistence** Savings, if they exist, often decline over time as technology develops and behaviour changes, but this is rarely taken into account.
- **Free-riding** Some participants in an energy efficiency programme might have installed the relevant measures themselves, even without the stimulus of the programme, and their actions should not therefore be counted as additional savings.
- **Gaming** It is also possible that some people defer energy efficiency investments in the expectation that they will at some future date be eligible for subsidy or support, since such programmes are both widespread and changeable.
- **Principal/agent slippage** Results may differ from the theoretical calculation because of the indirect method of delivery. The two main UK government programmes in this area are delivered by the gas and electricity supply companies. It is well known in economic theory that when programmes are delivered by agents in this way, their incentives may not be identical with the objectives of the principals. In the present case, the companies have compulsory carbon saving targets, which they meet by "promoting the uptake of low carbon energy solutions to household energy consumers".[26] It is, in principle, likely that the companies will be more concerned about doing what is necessary to meet the targets than whether those actions will in fact produce the expected reductions (and indeed they are not obliged to demonstrate actual reductions, as discussed below). In other words, there is a risk that the exercise becomes a form of box-ticking, with the action taken being the minimum necessary to ensure formal compliance, rather than what would truly promote the underlying objective.
- **Appraisal optimism** It is a common feature of almost any ex ante calculation that a degree of optimism feeds into the assessment so that it does not fully take into account the various contingencies which might serve to increase costs or reduce effectiveness. Indeed so well is this recognised that the UK Treasury produces guidance on Optimism Bias which recommends that project appraisers should make explicit adjustments to the estimates of project costs, benefits and duration based on

[26] DECC website.

empirical data to inform project decisions[27]. It is arguable that proponents of energy efficiency are particularly prone to this sort of bias, for instance in the tendency to take account of (positive) spillover and market transformation effects and ignore or downplay the various offsetting negative effects. To measure the size of the impact of appraisal optimism it is necessary, as the Treasury notes, to have empirical data yet, empirical data about the actual impact of energy efficiency programmes are almost entirely lacking.

These sorts of effect are not unique to energy efficiency; they occur in many cases of intervention for policy or medical reasons. Procedures and practices exist for dealing with the potential measurement issues, which have been particularly well-developed for medical interventions (drug testing, epidemiological studies and the like). They include:

- **Randomised control trials** under which participants in a study are allocated on a random basis to different groups, only one of which receives the intervention under test. Both groups are followed up in the same way so that the non-intervention group acts as a sort of baseline against which the impact of the intervention can be measured.
- **Double blind studies** in which neither the participants in each group or the testers know which group is receiving the active intervention and which is receiving a placebo. This is necessary because the very knowledge that a group is subject to a trial may itself change behaviour.
- **Longitudinal cohort studies** These involve repeated observations of the same group or groups, often over long periods of time. They thus identify whether behaviour has changed and how persistent the result of any intervention has been.
- **All outcome measurement** Health studies, for instance, aim to measure all health outcomes not just the impact on the specific health problem targeted, so as to understand the various side effects.
- **Controlling for confounding factors** In many cases, there may be other factors, in addition to the specific object of study, which could be having an influence on the result – for example, in any epidemiological study of the link between some foodstuff and cancer the researchers would want to control for the impact of cigarette smoking, which is known to be carcinogenic, in case there happened to be a link between the consumption of that foodstuff and of cigarettes.
- **Independent arbiter** Given the existence of risks such as appraisal optimism and principal/agent slippage, it is common to introduce an independent arbiter into the system to decide whether an intervention has been demonstrated to be worthwhile – such as the National Institute for Health and Clinical Excellence (NICE) in the UK.

In practice, very little of the above is ever attempted in relation to energy efficiency interventions – it is too expensive and in some cases (like double blind trials) probably impracticable. Instead a very much simpler methodology is applied to the CERT programme:

- A carbon saving score is estimated for each of the possible measures supported under the scheme (eg additional insulation, high efficiency light bulbs etc). The calculations are based on modelling by expert bodies – eg for building fabric interventions

[27] HM Treasury website

BREDEM, the Building Research Establishment Domestic Energy Model (or family of models), is used.

- Suppliers implement a range of measures and report data on numbers to the electricity and gas regulator, Ofgem.
- Ofgem checks the data (ie in terms of numbers of measures installed).
- It then calculates the savings by multiplying the number of measures by the score for each measure.

This leads it to such specific conclusions as the following, from its latest report on the outcomes:

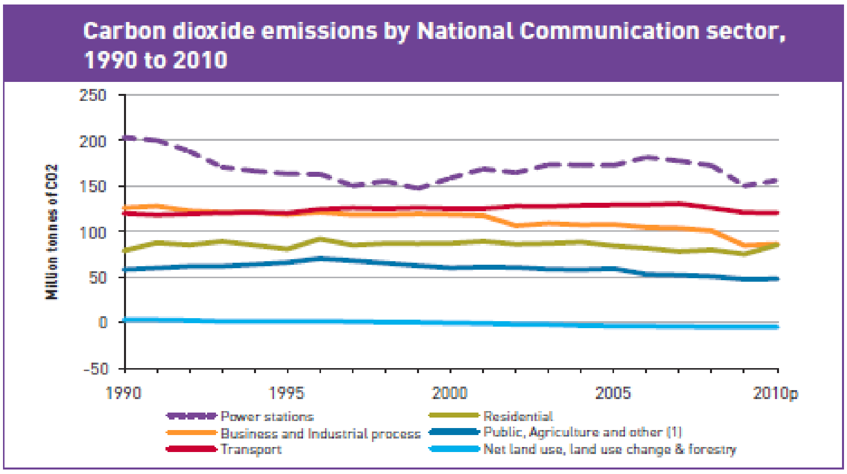
"By the end of the third year, suppliers had collectively delivered measures resulting in approximately 197 Mt CO_2 … excluding innovation uplifts. This equates to 67% of the overall target of 293 Mt CO_2. Overall, energy suppliers are therefore on track to meet the target." [28]

But, as will be apparent from the list of potential issues above, the claimed savings, and the precision of the claim, cannot be justified. Nor can they be seen in the overall residential sector data, below, for recent years.

Residential sector emissions have been broadly stable over the past twenty years or so, rising and falling with such factors as the weather and fuel prices. If 197 Mt had really been saved, it should be apparent in the data, but it is not – in fact, emissions have risen since 1990. As with the intensity comparisons, any savings, if they exist, are against some theoretical baseline which might or might not have any real significance. Theoretical savings such as this are not a way of achieving an ambitious national emissions reduction target. It will be noted that, by contrast, sectors such as power and business and industrial processes are showing absolute emissions savings – most of which can in fact be ascribed to fuel switching and changes in activity, rather than energy efficiency.

[28] Ofgem *A Review of the Third Year of the Carbon Emissions Reduction Target* August 2011

Figure 3: Carbon Dioxide Emissions by National Communication Sector, 1990 to 2010



(1) Includes emissions from Public, Agriculture, Waste Management and other Energy supply.

Million tonnes of carbon dioxide

	1990	1995	2000	2008	2009	2010p
Power stations	203.4	163.4	163.1	172.4	150.3	156.2
Residential	79.0	80.8	92.0	79.9	75.2	85.3
Public, Agriculture and other (1)	58.2	66.0	70.4	50.7	47.6	48.1
Business and Industrial process	126.0	118.8	121.3	100.8	84.7	86.3
Transport	120.0	120.2	124.6	126.0	120.8	120.6
NLULUCF	3.1	1.6	1.4	-4.7	-4.8	-4.8
Total CO_2 emissions	**589.7**	**550.8**	**549.4**	**525.1**	**473.7**	**491.7**

Source: AEA, DECC (2010 provisional figures)

The government does assess the impact of the programmes, beyond the ongoing measurement efforts, but again the evaluations[29] tend to focus on the bottom-up numbers – how many measures, of what type, by which companies etc. Some effort is made to assess such factors as deadweight and "uplift" but again the method used is comparison with a notional baseline, rather than comparison with an actual control group. Various individual studies have also been made of such factors, and the methodologies and results vary widely. For instance, on the question raised above, of whether the BREDEM results correspond with actual measured savings in homes, one study[30] has suggested that a "reduction factor" (including technical factors as well as rebounds) of 50% should be applied – much higher than the government's assumptions.

A number of "meta-studies" has also been conducted of the impact of energy efficiency programmes in general, which look at the range of published studies to determine the size of rebounds. Two are singled out for particular notice. They are of interest because they reach similar conclusions, conclusions which are however very much undermined on reading the detail of the studies themselves. One is the article *Energy efficiency and consumption – the rebound effect – a survey*[31] by Greening et al, which appeared in the issue of *Energy Policy* referenced above and looks mainly at the US. They reach the conclusion that "Estimates of

[29] For example *Evaluation of the Energy Efficiency Commitment 2005-2008* Eoin Lees Energy December 2008. Available on website www.eoinleesenergy.com.
[30] Sanders C and Phillipson M *Review of Differences between Measured and Theoretical Energy Savings for Insulation Measures* Glasgow Caledonian University, December 2006
[31] Greening L, Greene D and Difiglio C Energy Policy 28 (2000) 389-401

the rebound are very low to moderate …. The rebound is not high enough to mitigate the importance of energy efficiency as a way of reducing carbon emissions." Similarly, the major UKERC study referenced above concludes that "The key message is that promoting energy efficiency remains an effective way of reducing energy consumption and carbon emissions".

These conclusions have been relied on by many commentators to justify the continuation of existing policies when in fact a more careful reading should rather suggest a need for more research – as indeed both studies recommend – a more careful targeting of policies, better monitoring, and little support for any particular estimate of energy savings. The Greening et al study, for instance admits "In the majority of end uses, data collection or end-use metering studies are lacking". The study ignores transformational effects because they are too difficult to measure. The cases examined show an enormous range of results – for instance, on the long run impacts of industrial measures the authors comment rather wearily that they have looked at "any number of studies with a variety of conclusions". Unsurprisingly, perhaps, they recognise that "because of the identification and measurement issues …. [their] conclusion is not definitive at the microlevel" while "even less work has been performed on the macroeconomic implications of the rebound" and "any conclusions on the effects of the rebound at the economy-wide level are even more tentative".

The UKERC study conclusions are similarly heavily qualified. It notes that "the evidence base is remarkably weak" that "time costs are an important but relatively unexplored issue" that "policies to address market barriers may be insufficient, since rebound effects could offset much of the savings". The ranges it gives for the calculations of direct rebounds are huge – 10-58% in the short run for domestic heating, 1.4-60% in the long run, for instance. Like the US study, it notes the importance, but uncertainty, of economy wide effects, which "could potentially increase energy consumption in the longer term". After reviewing analyses of this sort it concludes that "All of the studies find economy-wide rebound effects to be greater than 37% and most studies show either large rebounds (>50%) or backfire [ie >100%]." This, in fact somewhat understates the results of the economy wide studies. Of the 8 studies listed in Table 4.1 of the UKERC survey, for instance, 4 show rebound effects of over 100%. In principle, these economic studies should give a more accurate overall picture (because of the boundary problem discussed above, the bottom-up studies will never give a full analysis of the effects). The UKERC survey points out, correctly, that the economic studies all have a number of flaws, but it is not at all obvious from the discussion that these flaws are greater than those of the bottom-up studies (and the problems with such studies go much wider than rebounds, as discussed above). An alternative interpretation is that the economic studies are more likely to be approximately right, while the bottom-up studies are almost certainly precisely wrong. Perhaps recognising the weak ground they are on, in both studies the conclusion that energy efficiency policies are justified is associated with support for carbon taxes – ie that energy efficiency should be seen as a complement, not an alternative, to taxation.

Furthermore, very few studies have looked at the question of absolute reductions – ie whether actual reductions in energy consumption have been realised as opposed to a reduction against some notional baseline (and given the absence of controls or empirical data collection this is unsurprising – most studies have no way of knowing whether there have been any actual reductions). However, it is noteworthy that even the IEA, which is a strong supporter of energy efficiency, reaches the conclusion that there are only a "few specific examples where the energy savings from …. energy efficiency …. have outstripped the growth in energy demand"[32] . In fact, these few examples are not very convincing[33]; in any event, the report concedes that overall "other factors …. are in general driving up energy demand to a greater degree than efficiency improvements are constraining demand". Similarly a UK study concluded that "energy efficiency should help to counteract the trends towards increasing consumption but in the short term the effect may be fairly small" and "energy consumption by households has increased despite trends towards greater energy efficiency".[34]

Meanwhile, some of the flaws in the economic studies noted by UKERC are being addressed. One such very recent piece of work reviewed Canadian demand side management (DSM) programmes. It took advantage of the fact that effort on these programmes had fluctuated over time so that if they were really making a difference, this ought to be apparent from the overall figures. It concluded that: "In aggregate DSM expenditures by Canadian electric utilities have had only a marginal effect on electricity sales". The authors believe that "The method we use [a partial-adjustment dynamic model of electricity demand] …. directly accounts for the net effect of free ridership, rebound effect and within-jurisdiction spill-over".[35]

In short, the evidence from various sources – bottom-up programme measurement, econometric analysis, the historical record, economic theory – is ultimately inconclusive about the impact of energy efficiency on demand. The bottom-up studies tend to show reductions but the measurement is not rigorous and the extent of the apparent reductions depends on the methodology used; furthermore, the supposed reductions do not appear in figures for aggregate demand (which is what matters). The economic studies tend to show either minimal reductions or increases at aggregate level. The historical studies show differing outcomes depending on the technology and circumstances. Economic theory could lead in either direction. In short, there are as many reasons to believe that energy efficiency increases demand as that it reduces it.

At the detailed level of particular UK energy efficiency programmes, the impact on energy demand and emissions, if it exists, is only marginal and consists of theoretical reductions compared with some growth baseline. It is clear from the national data that any actual reductions are not on a scale remotely comparable with the relevant environmental targets – the UK has a legally binding target of reducing greenhouse gas emissions by 80% by 2050, under the Climate Change Act 2008.
Ultimately, however, the position is unclear, because the programmes do not receive rigorous assessment of the sort that would be applied in other policy areas. There is therefore at present insufficient evidence to justify particular energy efficiency policy measures on environmental grounds.

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[32] *The experience with energy efficiency policies and programmes in IEA countries* IEA Paris 2005 p33

[33] One of the examples, for instance, is that of refrigerators in the US. But while it is true that over the past two decades energy use per refrigerator has roughly halved, the number of refrigerators has increased substantially, leaving refrigerator energy use roughly constant. (Yergin D *The Quest* Allen Lane 2011 p 630).

[34] *Energy and Environment* vol 11 no 5 p 553-564

[35] Rivers N and Jaccard M *The Energy Journal* vol 32 no 4 p 93-116

Interaction with Other Policy Measures

It is beyond the scope of this note to look at all the alternative policy measures for emissions reduction, such as carbon taxes and switching to low or zero carbon sources. In general they do not suffer from the same uncertainties and feedback effects as energy efficiency so are more likely to have a measurable impact on emissions (though of course this would have to be appraised critically for any specific policy proposal). But it is worth drawing attention to some interactions between energy efficiency and other measures, which can tend to offset any reduction in emissions. First, there is the simple fact that if energy supply is being decarbonised anyway, the emissions savings from any reduction in demand (if indeed it happens) will decline, so that the cost effectiveness of energy efficiency measures in carbon mitigation terms will also be on a downward trend. For instance, the UK is planning to move to a low or zero carbon electricity system in coming decades – the aim is to get below 100g/kWh by 2030 and for system carbon intensity to continue decreasing. Since the present carbon intensity is around 500g/kWh, this means that each kWh saved in 2030 will produce only around one-fifth of the carbon savings expected today. When (if) the electricity system eventually reaches its zero carbon objective, electricity savings will no longer produce any emissions reduction. There may then be a social case for giving people help with energy efficiency to mitigate the higher cost of the future zero carbon electricity supply but there will be little environmental basis for doing so. Over time other sectors are also expected to decarbonise (often via electrification) so energy efficiency across the economy will increasingly start to lose its environmental justification.

This is not an argument for abandoning energy efficiency, but for framing forward-looking policies in which energy efficiency is seen more in the context of the future low carbon energy system rather than today's carbon-intensive and fossil-fuel based energy supply. This will often lead to a different approach designed to reduce customer impacts or (as with the DR discussed earlier in this note) to reduce overall system costs. More widely, the electricity system of the future, with increasing dependence on intermittent supply sources, more distributed power supply and new demand categories such as electric vehicles is likely to be based, not just on "smart grids" but on "smart consumers" – an active and empowered demand side which plays an important role, along with supply, in the management of the system[36]. Energy efficiency policies should be framed to encourage such smart consumption and help prepare the transition to a low carbon system, rather than just mitigating the impacts of current high carbon energy sources.

Similarly, there can be tensions between energy efficiency and fiscal measures like carbon trading and taxes. If, for instance, the EU managed to reach its objective of improving energy efficiency by 20% by 2020 and meanwhile we see little economic growth because of the euro-crisis and its aftermath, carbon prices under the European Emissions Trading Scheme are likely to remain low. While emissions would also be low under these conditions, the problem is that there would be little incentive for making low carbon investments for the longer term because of the low carbon price. So once the economy picks up again it may well be at a higher level of carbon intensity than otherwise. Again a better approach would be to integrate energy efficiency and carbon pricing policies with the aim of promoting the future low carbon energy system.

[36] Sioshansi 2012

These issues will be looked at in more detail in future OIES research and are only signalled at this stage. But what they do emphasise is an underlying conceptual issue – the environmental problem relates to carbon, rather than to energy as such; energy efficiency in many cases is simply aiming at the wrong target.

Conclusions

The main message of this note is not that energy efficiency should be discounted as a policy tool, but that not too much should be expected of it. It should be deployed in a more targeted fashion than at present, assessed much more rigorously and integrated more effectively into a wider low carbon strategy.

In particular, the analysis suggests the following conclusions:

- Most of the supposed barriers to energy efficiency are unlikely to be of such great continuing significance as is often supposed. However, there is a major exception – environmental externalities, and in particular greenhouse emissions resulting from energy use.
- That on its own would justify some energy efficiency programmes – while carbon taxes to internalise externalities may be desirable in principle, it may be socially and politically unacceptable to introduce carbon taxes at a sufficiently high level; it may also be justifiable to help consumers adapt to higher energy prices via energy efficiency improvements.
- However, any such measures require better justification, monitoring and assessment than they have received hitherto. It is doubtful if energy efficiency measures are as cost-effective (before taking account of the CO_2 savings) as has been suggested.
- It is also unclear whether the claimed energy savings have any real basis. Assessment of the programmes is rudimentary and the results are largely taken on trust.
- Future programmes should be designed to achieve a clear social or environmental goal, should be assessed effectively to show whether the goal is being achieved, and should be integrated into overall carbon strategies rather than a simple add-on.
- Until this happens, confidence in energy efficiency as a weapon in the effort to reduce emissions seems misplaced. It could even be counterproductive, if it leads to unrealistic expectations about the likely impacts of energy efficiency and to a diversion of attention from more effective measures (like switching to low carbon sources and carbon taxes).
- In short, it is time to take energy efficiency seriously – but that does not mean treating it as a panacea or even a first resort. Its costs, benefits and results should be assessed on a rigorous basis like those of any other programme and compared with them for effectiveness. Energy efficiency should not continue to get a free pass.