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THE EXPERIENCE WITH ENERGY EFFICIENCY POLICIES AND PROGRAMMES IN IEA COUNTRIES

Learning from the Critics

IEA INFORMATION PAPER

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SOUTHWEST ENERGY EFFICIENCY PROJECT
BOULDER, COLORADO, UNITED STATES

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Foreword

In the last thirty years, certain criticisms of energy efficiency policies have arisen at regular intervals in nearly all IEA member countries. The goal of this paper was to compile, categorise, and then evaluate those criticisms of energy efficiency policies. Some criticisms have merit, others less so. By compiling and evaluating them, we hope to minimise unproductive discussions and move forward towards more constructive and effective policies. Learning from the critics means modifying policies where the criticism is justified and staying the course where it is not. We also hope that policymakers will read this paper and use it when called to defend their efficiency policies (in fact, this has already happened).

This paper was greatly improved by contributors from around the world. Indeed, we were surprised by the enthusiastic response when we solicited requests for literature and circulated early drafts of this paper. People seemed to quickly grasp the value of such a compilation and analysis perhaps because they had faced precisely those questions in their own agencies or ministries.

This Information Paper is a work in progress. We expect that new criticisms of energy efficiency policies will appear – though perhaps in different contexts or in different countries — and we hope to update this study when enough new material becomes available.

This project was conceived and directed by Alan Meier at the International Energy Agency.

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The ideas expressed in this paper are those of the authors and do not necessarily represent views of the IEA or its member countries.

Introduction

Industrialised countries including France, Germany, Italy, Japan, the United Kingdom and the United States have significantly reduced their primary energy use per unit of GDP over the last three decades. Major OECD countries taken together used a third less primary energy to generate a unit of GDP in 2000 compared to 1973 (IEA 2004).

The decline in energy intensity has been driven largely by improved energy efficiency in key end-uses such as vehicles, appliances, space heating and industrial processes. A recent study by the International Energy Agency (IEA) provides a detailed analysis of how much of the decline in energy intensity (changes in final energy consumption per unit of GDP) was due to energy efficiency improvements (the “intensity effect” in the graph) and how much was due to structural changes (the “energy service/GDP bars in the graph). The overall results for 11 countries are shown in Figure 1. Regarding the intensity effect, the figures are based on the measure of energy efficiency in various sub-sectors (for some 30 end-uses) for 11 OECD countries.¹

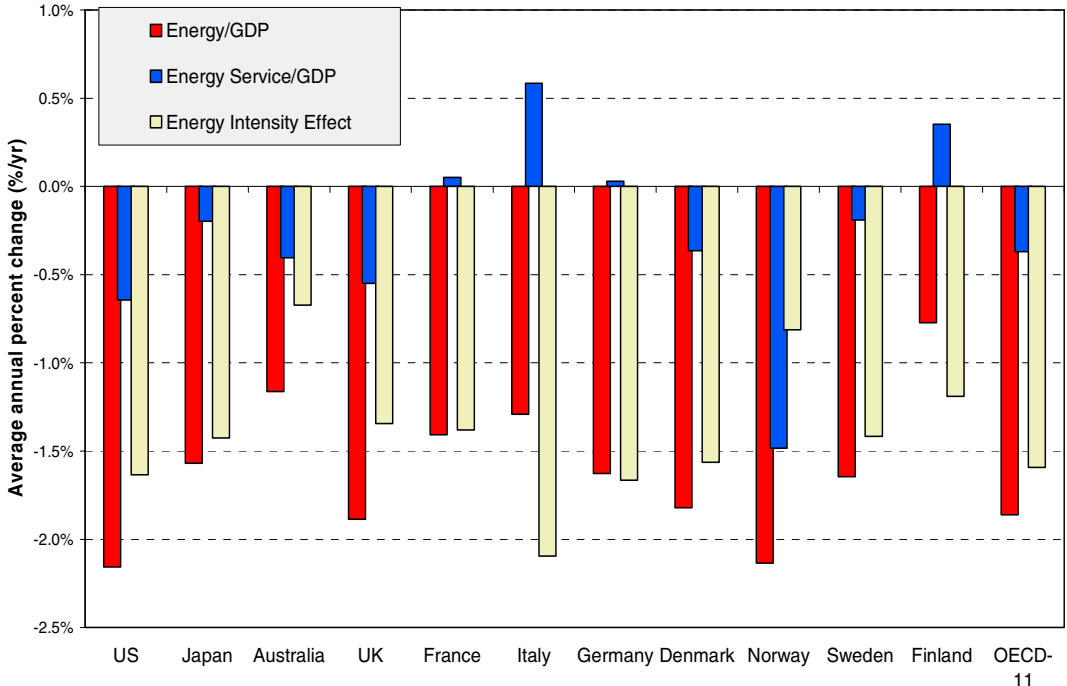


Figure 1. Changes in energy per GDP decomposed into changes in energy service per GDP and energy intensity effect, 1973-1998 (IEA 2004)

Figure 1 shows that overall energy use per unit of GDP declined more rapidly than energy service intensity for all countries except Norway. For all 11 countries as a whole, the energy intensity composite declined about 1.6% per year on average, compared to 0.3% annual average decline in energy services per unit of GDP. Thus, declining energy intensity (i.e. energy efficiency improvements) accounted for most of the drop in energy use per unit of GDP in OECD countries over the past 30 years.

¹ In this reference, energy intensity corresponds to energy use per unit of activity such as floor space heated or vehicle-kilometres driven.

Energy efficiency improvements result from ongoing technological progress, response to rising energy prices, and competitive forces pressuring businesses to cut all types of costs including energy costs. In addition, governments have implemented a wide range of policies and programmes such as funding research and development (R&D), energy efficiency standards, educational efforts, obligations on market actors and financial incentives to accelerate the development and adoption of energy efficiency measures. These policies and programmes have contributed to the improvement in energy efficiency experienced in OECD countries during the past 30 years (Bosseboeuf and Richard 1997; NAS 2001; Gillingham, Newell and Palmer 2004; NCEP 2004; Geller et al. 2005).

Proponents of energy efficiency policies and programmes argue that greater energy efficiency saves consumers and businesses money while reducing the adverse environmental impacts associated with energy production, conversion and use. In particular, greater energy efficiency is viewed as a strategy for reducing carbon dioxide emissions and helping countries meet their Kyoto Protocol targets. Energy efficiency advocates also argue that efficiency improvements can provide social benefits such as increased productivity and employment, reductions in the high energy cost burden faced by low-income households, improved comfort and public health, enhanced national security, and conservation of finite resources such as oil and natural gas (Romm 1999; Jochem 2000; Geller 2003).

Along with the proponents, there are critics of energy efficiency policies and programmes. These critics argue that energy efficiency policies and programmes are unwarranted or are a failure. Some of the most common criticisms found in the literature include:

- ❖ The rebound effect will erode most or all energy savings.
- ❖ The economy-wide effect will also erode energy savings.
- ❖ Most energy savings would happen anyway due to ongoing technological advances or rising energy prices.
- ❖ The discount rates used to justify energy efficiency policies and programmes are too low.
- ❖ Ratepayer- or taxpayer-funded energy efficiency programmes are an unfair subsidy that hurts non-participants and low-income households.
- ❖ Energy efficiency policies and programmes are much less effective than their proponents claim.
- ❖ The market failures frequently used to justify energy efficiency policies and programmes are mostly a myth.
- ❖ Energy savings are impossible to meter and too difficult or costly to estimate accurately.
- ❖ Energy efficiency is a failure because energy use has been increasing in OECD countries.

The purpose of this report is to first present each of these criticisms in what we hope is an accurate manner. We then respond to each criticism based on actual experience with energy efficiency policies, programmes and measures in OECD countries. From this review, we draw conclusions regarding the merits of each criticism. We also make suggestions as to how energy efficiency proponents, analysts and policy makers could improve the design and analysis of future energy efficiency policies and programmes, based on the issues raised by the critics.

In preparing this report, we made our best effort to seek material, both criticisms and responses to them, across a wide spectrum of countries. However, we found more relevant literature from the United States than from elsewhere. In particular, there is a paucity of published criticisms from Western Europe or Japan. On the other hand, there are a number of responses to criticisms from these regions, even if the criticisms are not explicitly stated. Because of this, the report contains more examples and citations from the United States than from other countries.

Nine Major Criticisms and Our Responses to Them

A. Will the Rebound Effect Erode Most or All Energy Savings?

One of the most common criticisms of energy efficiency policies and programmes is that they overstate energy savings by ignoring the direct rebound effect (also known as the takeback effect). This effect refers to the increase in the demand for energy services (heating, refrigeration, lighting, etc.) when the cost of the service declines as a result of technical improvements in energy efficiency. Because of the lower cost, consumers and businesses change their behaviour, e.g. raise thermostat levels in the winter; cool their buildings more in the summer; buy more appliances and/or operate them more frequently; or drive their vehicles more. This behavioural change erodes the energy savings due to the technical energy efficiency improvements.

Dan Khazzoom began this debate based on price elasticity arguments, contending that in the long run the rebound effect will erode most of the energy savings from insulating homes or increasing the energy efficiency of electrical appliances (Khazzoom 1980; 1987). Khazzoom and others such as Brookes (1992) and Inhaber (1997) have gone so far as to suggest that improvements in energy efficiency could result in an increase, rather than a decrease, in energy use due to the rebound effect. Khazzoom argues that this result will occur if the price elasticity of demand is greater than unity. It is suggested based on studies from the 1970s that the long-run price elasticity does in fact exceed unity for residential space heating, water heating and some types of household appliances (Khazzoom 1980; 1987).

Response

There is a large body of literature suggesting that the direct rebound effect is indeed real in many situations. The key issue is the magnitude of the rebound effect. Does empirical evidence suggest it is large or small? This question was addressed in an in-depth literature review prepared by the Office of Policy and International Affairs of the U.S. Department of Energy on behalf of the Energy Efficiency Working Party of the IEA (IEA 1998). A summary of this review was also published in the journal *Energy Policy* (Greening, Greene and Difiglio 2000). The authors examined econometric studies and direct measurements of the rebound effect for different sectors and major end-uses in the United States. They find that the effect is very small (less than 10%) for residential appliances, residential lighting and commercial lighting, and less than 20% for industrial process uses. For residential space heating, water heating and automotive transport, they find the rebound effect is small to moderate (<10-40%). And for residential space cooling, they find the rebound effect is in the range of 0-50% (see Table 1).

Table 1. Summary of Empirical Evidence of the Rebound Effect in the United States

Sector	End Use	Size of rebound effect
Residential	Space heating	10-30%
Residential	Space cooling	0-50%
Residential	Water heating	<10-40%
Residential	Lighting	5-12%
Residential	Appliances	0%
Residential	Automobiles	10-30%
Business	Lighting	0-2%
Business	Process uses	0-20%

Sources: IEA 1998; Greening, Greene and Difiglio 2000.

Greene (1998) looks in more detail at studies of the rebound effect associated with vehicle efficiency improvements in the United States, i.e. the change in vehicle use as the fuel cost per mile declines. He finds that the overall experience with fuel price and fuel economy changes over 25 years suggests a short run rebound effect on the order of 10% and a long run effect of about 20%. He notes, “the implication is that 80-90% of the maximum potential reduction in fuel consumption and greenhouse gas emissions due to a technical change in vehicle efficiency will be realised, even after the increase in vehicle miles due to lower per mile costs has had its full effect” (Greene 1998). Also, Greene found that the sensitivity of travel demand to fuel cost per mile has fallen over time as fuel cost as a fraction of the total cost of owning and operating a vehicle has declined and as incomes have risen (Greene 1992).

There have also been some empirical studies of the rebound effect in Europe. An analysis of residential building retrofits in Austria found a space heating rebound effect of 20-30% (Haas and Biermayr 2000). In the United Kingdom, Milne and Boardman (2000) found that about 30% of the potential energy savings from retrofit measures was taken as increased comfort in low-income households as of the late 1990s. But the magnitude of this rebound effect is declining over time due to the increasing penetration of central heating and increasing average indoor temperature.² In essence, the rebound effect is a dynamic phenomenon. It tends to decline over time as the saturation and quality of energy services increase.

It is important to note that the direct rebound effect, to the extent that it occurs, is not evidence that energy efficiency is a failure. It simply means that some consumers choose to respond to reduced energy costs in part by increasing their level of energy service, for example by increasing their level of space heating or cooling, rather than minimising energy consumption and energy costs. Energy efficiency improvements still contribute to an improvement in “general welfare” whether by enabling a higher level of comfort, increased activity, or lower energy cost, or some combination of these responses.

² The level of indoor heating and comfort was particularly poor in low-income households in the United Kingdom prior to retrofit efforts.

Summary

Energy efficiency analysts who suggest that the rebound effect erodes some of the energy savings due to technical efficiency improvements do make a valid point, based on the empirical evidence. Some consumers and businesses will increase their demand for energy services as the cost of the service declines. But empirical evidence suggests that the size of the rebound effect is very small to moderate, with the exact magnitude dependent on the location, sector of the economy, and end-use. Most of the direct energy savings from technical improvements in energy efficiency in OECD countries remain even after the direct rebound effect is accounted for.

Those suggesting that the direct rebound effect will lead to a net increase in energy use appear to be grossly exaggerating the magnitude of the phenomenon. Nonetheless, policy makers and energy efficiency proponents should account for a small to moderate rebound effect in projections of the overall energy savings due to energy efficiency policies and programmes. This is in fact recommended in a handbook on energy efficiency programme evaluation methodology (SRC International 2001).

B. Will the Economy-wide Effect also Erode Energy Savings?

Some energy analysts and energy efficiency critics point out that energy efficiency improvements on a large scale lead to broader macroeconomic impacts that in turn result in an increase in energy consumption. Saunders (1992), for example, states “energy efficiency gains can increase energy consumption by two means: by making energy appear effectively cheaper than other inputs; and by increasing economic growth, which pulls up energy use.”

Brookes (1992) argues on macroeconomic grounds that increasing energy efficiency will contribute to rising productivity and consequently greater energy use. Also, he points out that if energy efficiency efforts put downward pressure on energy prices, consumers will eventually respond to lower prices by increasing their demand for energy services and thus energy consumption. These economy-wide or “indirect rebound effects”, if valid, would further erode the energy savings from the technical efficiency improvements.

Inhaber (1997, p. xii) echoes these views, “So one group saves energy, making its price fall, and another group uses more as a result. What is the net effect? Overall, it is a wash, or even an increase in energy use.” He points to the example of auto efficiency and gasoline use in the United States, “gasoline use in this country has risen, not fallen, after the imposition of strict mileage standards for cars in the late 1970s.”

Response

There does appear to be some validity to the claim that increasing energy efficiency can contribute to lower energy prices and/or economic growth, and thus more demand for energy-consuming goods and services. For example, Laitner (2000) states, “there is the very real possibility that energy efficiency investments will improve overall national income and reduce energy prices.” But once again the question is how large are these effects? Based on their review of the U.S. literature, Greening, Greene and Difiglio (2000) conclude that this effect is very small — only about 0.5%, meaning more than

99% of the direct energy savings from energy efficiency improvements remain after the economy-wide effects are taken into account.

Widespread energy efficiency improvements can result in lower energy prices especially in tight energy markets. One recent study concluded that accelerated natural gas and electricity conservation efforts along with increased renewable energy investments in the United States would result in a 20% or greater reduction in wholesale natural gas prices in both the near and longer term (Elliott and Shipley 2005). Studies performed by the U.S. Energy Information Administration (EIA) also have found that accelerated energy efficiency improvements could lead to lower energy prices (Kydes 1997).

Energy efficiency proponents also suggest that widespread energy efficiency improvements can lead to a small increase in total productivity, income and GDP. Using input-output economic models, studies have found that consumers and businesses “respond” their energy bill savings from efficiency improvements in areas of the economy that are more labour-intensive and more productive than energy purchases. For example, one such study found that reducing U.S. primary energy consumption by 15% during 1995-2010 through energy efficiency improvements would result in 770 000 additional jobs, equivalent to a 0.44% increase in the overall employment rate, and \$14 billion in additional wage and salary income per year, equivalent to a 0.27% increase in income by 2010 (Energy Innovations 1997).

Energy efficiency proponents frequently fail to take into account the small “rebound” in energy use associated with lower energy prices and costs, rising income, or higher GDP induced by energy efficiency improvements. This is an oversight, but the magnitude is not large. In the Energy Innovations (1997) study, for example, accounting for the additional energy use associated with the projected rise in personal income would have lowered the energy savings projected in 2010 by less than 1%. Laitner (2000) notes that assuming the efficiency improvements in this study produced a 1% increase in GDP and a 6% reduction in energy prices on average, the “rebound” in energy use and CO₂ emissions would be only about 2.4% of the direct savings.

As with the direct rebound effect, the economy-wide effect is not evidence that energy efficiency is a failure. Energy efficiency improvements trigger a series of reactions that improve economic well-being, which in turn leads to a small increase in energy consumption. Once again, energy efficiency improvements still contribute to an improvement in “general welfare,” whether by enabling a higher level of comfort, increased economic activity, lower energy cost, or some combination of these responses.

Summary

There is validity to the claim that widespread energy efficiency improvements can lead to macroeconomic impacts that erode some of the direct energy savings due to energy efficiency improvements. However, various studies suggest that this effect is minimal — a loss of no more than 1 or 2% of the direct energy savings. Nonetheless, policy makers and energy analysts should take into account these economy-wide effects in studies of the impacts of energy efficiency policies or programmes at the national or regional level.

C. Would Most Energy Savings Happen Anyway Due to Ongoing Technological Advances or Rising Energy Prices?

Technological innovation has been occurring for many centuries, and technological innovation often brings with it energy efficiency improvements. Examples include new types of engines, new methods of steel production and new devices for artificial lighting (Grübler 1998; Huber and Mills 2005).³ Economists sometimes refer to this trend as autonomous energy efficiency improvement. Hogan and Jorgenson (1991) estimate that technological change alone causes overall U.S. energy intensity (E/GDP) to decline about 0.34% per year, independent of changes in energy prices. Some energy efficiency critics contend that these ongoing technological advances, not specific policies or programmes, are the primary cause of any energy savings (Inhaber 1997; Huber and Mills 2005).

Jaffe, Newell and Stavins (1999) argue that U.S. room air conditioner efficiency would have risen to some degree autonomously after 1975, even if air conditioner efficiency standards had not been adopted. Likewise they point out that energy price increases would have driven air conditioner efficiency further upwards to some degree. On this basis, they conclude that the energy savings from room air conditioner efficiency standards are much less than that claimed by energy efficiency proponents.

Other critics contend that increasing energy prices were the main reason why the fuel efficiency of new cars and light trucks increased during the 1970s and 1980s. Crandall et al. (1986), for example, concluded that almost all of the fuel economy improvement in new passenger vehicles in the United States during 1970-83 was due to the world oil price shocks.

Sutherland (2003) claims that the decline in the energy consumption of new refrigerators in the United States from about 1 800 kWh/year in 1974 to about 800 kWh/year in 1990 is due to increasing electricity prices, not energy efficiency standards or other policies. He makes similar claims for other appliances such as clothes washers, dishwashers, and room air conditioners, pointing out that national efficiency standards did not take effect until 1990.

Response

There is little argument that ongoing technological advancement leads to reductions in the energy intensity of specific processes and services, as well as the economy as a whole. Grübler (1998) points out that the overall energy intensity (E/GDP) of the U.S. economy declined about 1% per year on average for the past 200 years. In some sense this is an indicator of the long-term rate of autonomous energy efficiency improvement, expressed in terms of overall energy intensity. It is worth noting, however, that the rate of energy intensity reduction accelerated to 2% per year in the U.S. during 1973-2003 (EIA 2004).

Household appliances are one area where there have been strong energy efficiency improvements in all industrialised countries in the past 30 years. A number of studies show that these improvements were driven primarily by efficiency standards along with labelling and incentive schemes (IEA 2000;

³ It takes about 30 times less carbon (energy) to produce a ton of steel today compared to steel production prior to 1800 (Grübler 1998).

Waide 2001; Nadel 2002). In Europe, the average efficiency of new refrigerators and freezers was static or even declining prior to directives on energy efficiency labelling and standards. Thus the 27% decline in the average electricity use of new refrigerators and freezers sold in the EU between the early 1990s and 1999 was attributed to labelling and standards (Waide 2001; Boardman 2004).

There are also examples of European incentive programmes demonstrating very positive results. One-third of Dutch households received rebates for purchasing energy-efficient appliances during 1999-2001. During this period, the market share for A-labelled refrigerators increased from 26% to 67%, and the market share for A-labelled clothes washers increased from 40% to 88% (Wuppertal Institute et al. 2003). Later, the rebates were only given for the new subclasses of A+ and A++ appliances which consume 25-40% less electricity than models that are just A-rated. After the programme ended in 2003, the market share of A+ and A++ appliances was three times higher in the Netherlands than in any other European country (Thomas 2005a).

Regarding U.S. appliance efficiency improvements, it is important to recognise the contribution of state as well as national appliance efficiency standards. California first set appliance energy efficiency standards that took effect in 1976, and subsequently strengthened its standards. Other states followed suit in the 1976-86 time period. Nadel (2002) points out that the largest improvements in product efficiency were close to the effective dates of new standards (see Figure 2). He also cites statements by U.S. appliance manufacturers indicating that the standards led to the substantial improvements in appliance energy efficiency.

There are examples where energy efficiency proponents or analysts estimate the savings potential and cost-effectiveness of particular energy efficiency policies assuming that efficiency levels will remain static over time in the absence of the policies. For example, in calculating the energy savings from the adoption of industrial technologies which the U.S. Department of Energy (DOE) has helped to develop and commercialise, the DOE takes credit for all of the energy savings from adoption of these technologies (OIT 2001). No adjustment is made for technologies that may have been developed and sold in the absence of DOE support. By ignoring the long-term trend for technological innovation and lower energy intensity, these studies most likely overstate the energy savings that the policies and programmes achieved.⁴

On the other hand, many energy efficiency proponents and analysts assume that energy efficiency levels will increase to some degree in the absence of market interventions. This is done, for example, in the evaluation of potential appliance efficiency standards in the United States (Koomey et al. 1998) as well as in studies by leading U.S. energy efficiency advocates (Energy Innovations 1997). Likewise, an analysis of energy efficiency potential in the United Kingdom assumes that there will be some improvement in efficiency in the absence of new policy initiatives (Grubb et al. 1991).

⁴ This issue is also addressed in section F, the criticism that energy policies are much less effective than their proponents claim.

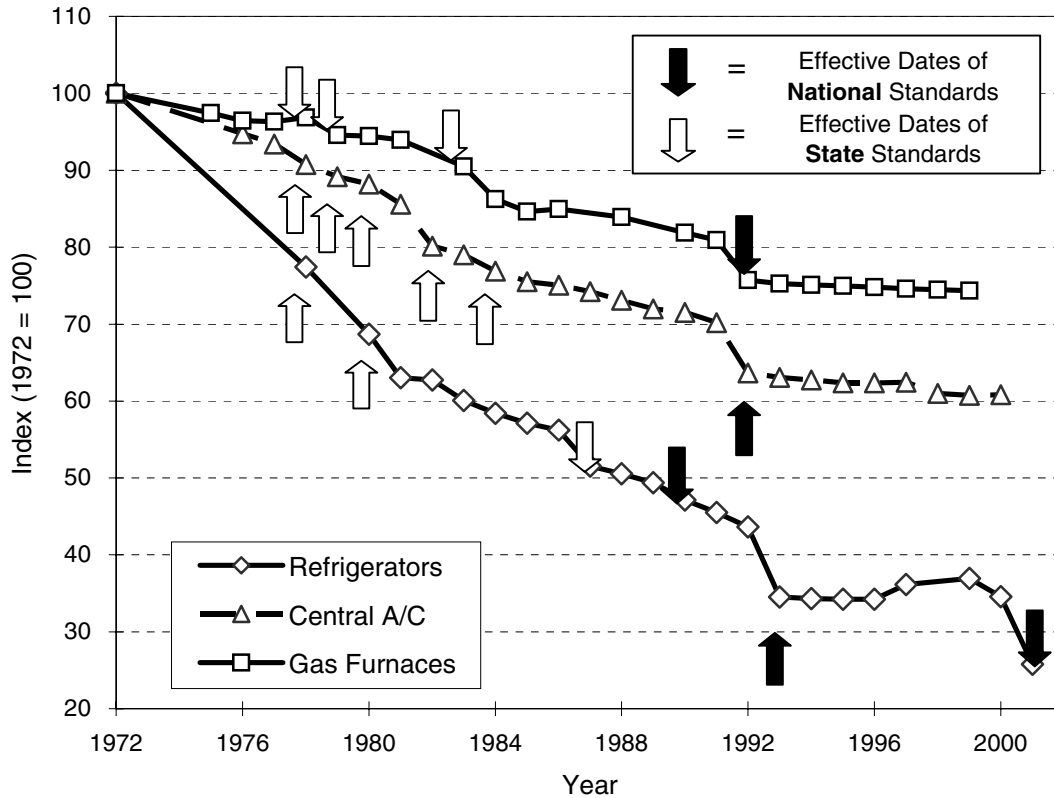


Figure 2. Trends in the Energy Efficiency of Major U.S. Appliances (Nadel 2002)

Regarding the question of how much of the improvement in energy efficiency was due to rising energy prices, this depends to a large degree on the price elasticity that is estimated. In the area of vehicle efficiency improvements in the United States, Greene (1998) concludes that the long run price elasticity is only about -0.20. This in part leads Greene to conclude that the CAFE fuel economy standards, not changes in fuel prices, were the main reason for the substantial improvement in the fuel efficiency of new vehicles sold in the U.S. between 1975 and 1995. Likewise, the National Academy of Sciences concluded, “CAFE standards have played a leading role in preventing fuel economy levels from dropping as fuel prices declined in the 1990s” (NAS 2001).

In the case of electricity, Verbruggen and Couder (2003) review data from 20 OECD countries and conclude that the long-run electricity price elasticity is -0.9-1.0. They also note that some countries such the Netherlands have lower electricity intensity than other countries, which they attribute to energy efficiency initiatives. Furthermore, the real (inflation-adjusted) price of electricity declined or remained relatively constant in most OECD countries between 1973 and 2000 (IEA 2004).⁵ This suggests that even if the price elasticity is relatively high, improvements in the efficiency of end-uses such as appliances and lighting were not caused by changes in electricity price.

⁵ Electricity prices did rise in most countries in the 1970s and early 1980s, but later declined.

Summary

It is true that technological innovation has lowered the energy intensity of industrialised countries for centuries. However, the rate of reduction has increased in recent decades in combination with the adoption of specific policies to increase the efficiency of energy use in all sectors. A number of studies have concluded that policies and programmes, not ongoing technological trends or (at times) rising energy prices stimulated most of these efficiency gains.

Policy makers and energy efficiency proponents should take into account the long-term trend towards lower energy intensity (i.e. so-called autonomous efficiency improvements) as well as consumer response to changing energy prices when evaluating the effectiveness of energy efficiency policies and programmes. But this does not mean that policies such as vehicle or appliance efficiency standards, grants or tax incentives for energy efficiency measures, or utility incentive schemes are by definition ineffective. Each energy efficiency policy and programme should be analysed based on its own characteristics and the context in which it has been (or will be) implemented.

D. Are the Discount Rates Used to Justify Energy Efficiency Policies and Programmes Too Low?

Energy efficiency proponents and analysts typically use a real discount rate of 4-8% to evaluate the cost-effectiveness of energy efficiency policy or programme options.⁶ The U.S. Department of Energy, for example, uses a real discount rate of 7% to analyse the costs and benefits of federal appliance energy efficiency standards to consumers (McMahon et al. 1996). The American Council for an Energy-Efficient Economy (ACEEE) uses a 5% real discount rate in its policy assessments (Nadel and Geller 2001; Kushler, York and Witte 2005). Using discount rates of 4-8%, policies such as vehicle or appliance efficiency standards, utility demand-side management programmes, and education and promotion programmes are cost-effective, with the net present value of the energy savings exceeding the first cost of the efficiency measures along with the administrative cost of the policy or programme.

Some energy efficiency critics suggest that much higher discount rates should be used to evaluate the cost-effectiveness of energy efficiency policies, programmes or measures. Hassett and Metcalf (1993) suggest that the irreversibility of energy efficiency investments as well as the heterogeneity of the marketplace, e.g. the variation in energy savings that different consumers will experience from adopting a particular energy efficiency measure, justifies use of relatively high discount rates. Sutherland (2003) suggests the appropriate discount rate for evaluating residential energy efficiency investments is 21-28%.

Numerous analysts have determined the “implicit discount rates” inherent in consumer or business energy efficiency purchases in the marketplace. The implicit discount rate is the discount rate that equalises the first cost of energy efficiency measures (or the extra first cost for more efficient products) and the value of the energy savings over the life of the measures, on a net present value basis. Studies of consumer purchase decisions in the 1970s and 1980s in the United States revealed implicit discount rates of 20-35% on average for room air conditioners and home insulation (Hausman 1979; Hartman and Doane 1986). Even higher implicit discount rates were estimated for other

⁶ The term “real discount rate” means the discount rate with inflation removed.

appliances such as refrigerators, water heaters and furnaces during 1972-80 (Ruderman, Levine, and McMahon 1987).

Some energy efficiency critics suggest that these implicit discount rates be used to evaluate policies such as appliance efficiency standards or utility DSM programmes. They then conclude that the policies and programmes would no longer be cost-effective if these much higher discount rates were used in the cost-benefit analysis (Inhaber 1997; Sutherland 2003). These arguments can have an impact on policy makers. For example, a major report sponsored by the Australian government suggests that implicit discount rates be used in the economic analysis of appliance and building energy efficiency standards (Productivity Commission 2005).

Response

First, as Jaffe and Stavins (1994) acknowledge, the observation that there are high implicit discount rates in the marketplace is simply a restatement of the existence of the energy efficiency “gap” (see item H below). If market failures and barriers are inhibiting widespread adoption of otherwise cost-effective energy efficiency measures, then by definition implicit discount rates will be high. It may be that these market failures and barriers, not conscious decisions by consumers, cause the high implicit discount rates.

Ruderman, Levine and McMahon (1987) found implicit discount rates of 80% or greater with respect to consumer investment in the energy efficiency of water heaters, refrigerators and freezers in the 1972-80 time period. In the case of gas water heaters, the implicit discount rates were 500-800%.⁷ Furthermore, the authors found that these implicit discount rates generally increased during 1972-80 in spite of significant increases in residential energy prices during this period. The authors attribute these very high implicit discount rates to a variety of market imperfections and barriers including lack of consumer awareness, misplaced (split) incentives, and the limited availability of energy-efficient products in the marketplace. They did not find any empirical evidence showing that consumers consciously choose to use discount rates as high as 800% (Ruderman, Levine and McMahon 1987).

Public policy analysis normally gives considerable weight to future costs and benefits, i.e. makes use of a relatively low discount rate. In Europe, the 25 Member States currently use real discount rates between 4.4% and 8.6% to evaluate policies and investments in general.⁸ In France, the French Planning Office recently lowered the discount rate used by all public agencies from 8% to 4%. This was done in order to give greater weight to costs and benefits that occur in the future, thereby fostering temporal and intergenerational equity. Moreover, there does not appear to be justification for using a different discount rate for analysing energy efficiency policies or programmes compared to other types of government policies and programmes.

Discount rates in the vicinity of 4-8% are not only used by energy efficiency advocates and government agencies. Many utilities use discount rates of 4-8% real to evaluate the cost-effectiveness of their energy efficiency programmes. In California, for example, the policy in recent years has been

⁷ An implicit discount rate of 500-800% means that efficiency measures with a payback of more than about five months are not being adopted in the marketplace.

⁸ For information on the discount rates of the EU Member States, see http://europa.eu.int/comm/competition/state_aid/others/reference_rates.html.

to use a nominal discount rate of 8.15%, equivalent to a real discount rate of about 5%. Using the utility's average cost of capital is another option that can be employed to evaluate the cost-effectiveness of DSM programmes. This creates a "level playing field" for assessing the relative merit of demand-side and supply-side investment options.

Energy efficiency policies and programmes are increasingly motivated by a desire to reduce greenhouse gas emissions and thus global warming. Since global warming is a serious threat to the well-being of future generations, Cline (1992) argues for using a lower discount rate to evaluate options for reducing greenhouse gas emissions than is normally used to evaluate government investments or public policies. He suggests using a real discount rate in the vicinity of 2%, well below the 4-8% typically used to analyse the cost-effectiveness of energy efficiency policies and programmes.

Summary

It is true that discount rates implicit in consumer purchases related to energy efficiency investment are often much higher than those used to evaluate energy efficiency policy and programme options. However, it appears that implicit discount rates reflect the wide range of market failures and barriers inhibiting greater investment in energy efficiency, not conscious choices by consumers and businesses. There does not appear to be a good theoretical basis for using implicit discount rates for evaluating the cost-effectiveness of energy efficiency options.

Policy makers should analyse the cost-effectiveness of energy efficiency policies and programmes using at most the same discount rates that are used to analyse other government policies or programmes, or energy supply investment options in the case of utility efficiency programmes. This usually means a real discount rate in the range of 4-8%. And if the primary objective is greenhouse gas emissions abatement, policy makers may want to use an even lower discount rate.

E. Do Ratepayer or Taxpayer-funded Energy Efficiency Programmes Hurt Non-participants and Low-income Households?

Energy efficiency proponents support efficiency standards, utility-funded incentives, and other types of policies to stimulate greater adoption of energy efficiency measures, as long as the energy efficiency "resource" is more cost-effective than an alternative energy supply resource. The funding for implementing these policies or programmes is normally provided by households and businesses as a whole through either general taxes or utility tariffs.

Some efficiency critics claim that these incentives are an unfair subsidy and money transfer among taxpayers or utility customers. Inhaber (1997, p. 58) states, "When public utilities subsidise home insulation and low-energy-use lightbulbs, it is a tax on the rest who do not take advantage of these measures." Brookes (2000) states, "Pursuing maximum energy efficiency by government dictat or subsidy is bound to lead to inequities because the most efficient response to an energy constraint will differ from use to use and user to user. The U.K. government scheme to provide funds for subsidising condensing boilers is especially inequitable."

Some energy efficiency critics suggest that low-income households in particular are hurt because they are underserved or penalised in some way by government or utility energy efficiency programmes. Sutherland (2003), for example, claims that U.S. appliance efficiency standards are particularly regressive, benefiting middle- and upper-income households much more than low-income households.

The very high implicit discount rates of low-income households are another issue raised by energy efficiency critics. Hartman and Doane (1986) examined consumer purchases of home insulation in Pennsylvania and New Jersey, finding that low-income households exhibited implicit discount rates of 53-88%. These implicit discount rates are much higher than those exhibited by wealthier households. Hausman (1979) found similar results with respect to consumer purchases of room air conditioners, with the lowest income group exhibiting an implicit discount rate of 89% (see Figure 3).

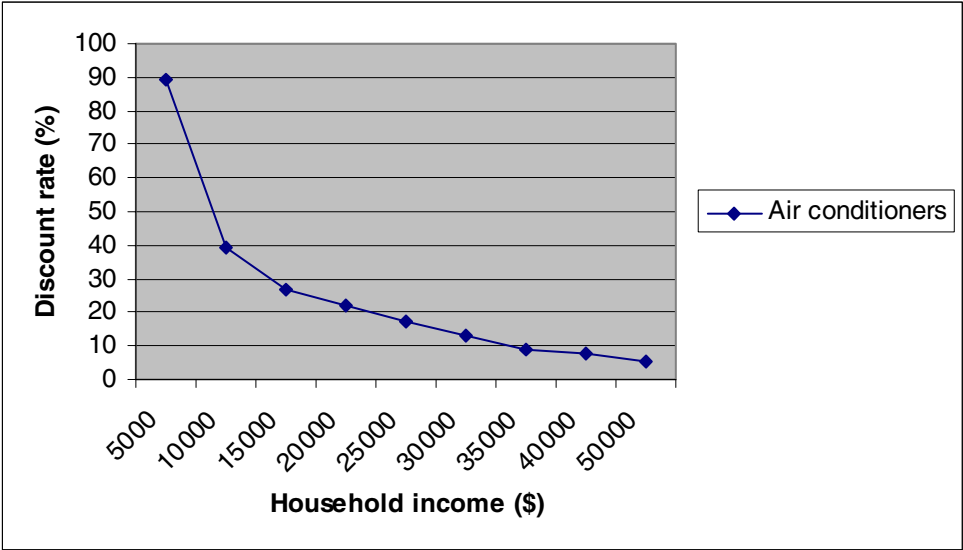


Figure 3. An Example of Implicit Discount Rates in Energy Efficiency Purchases as a Function of Household Income in the United States (Hausman 1979)

Train (1985) reviewed 14 studies that examined implicit discount rates as a function of household income. In all cases, the discount rates increased as income declined. This means that utility and other energy efficiency programmes may not be cost-effective for low-income households, if one assumes that implicit discount rates should be used to evaluate programme cost-effectiveness. Likewise, it is alleged that by removing lower first cost, less efficient models from the marketplace, appliance efficiency standards penalise low-income households that would prefer to purchase such models (Sutherland 2003).

Response

Regarding the issue of energy efficiency policies and programmes representing a subsidy from non-participant to participants, it is true that DSM programme participants will benefit the most while non-participants may see their energy prices increase slightly in the short run. But all consumers will benefit as energy efficiency improvements avoid or defer the need for costly investments in new power plants and other energy supply infrastructure over the long run (Hirst 1991). In addition, all consumers receive the indirect benefits of energy efficiency policies and programmes such as the

reduction in pollutant emissions, downward pressure on energy prices (see section B above), reduction in energy imports, or increased energy security or reliability (Geller 2003).

The issue of participants vs. non-participants is not unique to utility energy efficiency investments. The same is true for investments in new power plants or transmission and distribution equipment. Only some customers contribute to the need for these capital-intensive investments. But all utility customers pay for them through general rates. Energy efficiency proponents argue that demand-side investments should be treated the same way, and that it is desirable to have all ratepayers (or taxpayers) fund energy efficiency programmes as long as the cost of saved energy is less than the avoided cost of supplying energy (Moskovitz 1989). Furthermore, giving all ratepayers (or taxpayers) an opportunity to participate and implementing programmes for many years can maximise participation over the long run, thereby minimising any adverse distributional effects.

Regarding the issue of whether or not energy efficiency programmes represent a cross-subsidy from low-income to upper income households, a number of OECD countries have in fact emphasised assistance to low-income households (i.e. reduction of so-called fuel poverty) in their national energy efficiency programmes. The U.K. government targeted a large fraction of grants for insulation and other home retrofit measures to low-income households during 1978-96. The programme was successful in both saving energy and increasing comfort, i.e. enabling occupants to raise their thermostat levels in the winter (Shorrocks 1999). Also, the U.K. funded a successful programme that enabled low-income households with inefficient but functioning refrigerators to obtain a new efficient refrigerator (Boardman 2005).

The current Energy Efficiency Commitment (EEC) programme, which directs U.K. electricity suppliers to operate energy efficiency programmes for residential consumers and achieve specified levels of energy savings, requires that 50% of the energy savings come from low-income households. In fact, the EEC programme is reaching and providing benefits to the majority of low-income households in the U.K. (OFGEM 2004).

In the United States, about 25% of the U.S. Department of Energy's \$875-900 million annual expenditure on energy efficiency R&D, demonstration, and deployment efforts went to retrofit low-income homes as of 2002-04. This programme, known as the Weatherization Assistance Program (WAP), has helped about five million families reduce their energy consumption since 1976. Likewise, many U.S. states and electric utilities dedicate a sizeable fraction of their total "public benefits" programmes to bill payment assistance or energy efficiency services for low-income households (Kushler, York and Witte 2004).⁹

Regarding the very high implicit discount rates observed in appliance and insulation purchases by low-income households in the United States, this is a consequence of many factors including the large fraction of low-income households living in rental property, lack of disposable income, lower education levels, and limited availability of energy-efficient options (Train 1985). It does not mean that low-income households consciously choose to use discount rates of 50-100% in their energy efficiency purchase decisions, if they are making these decisions.

⁹ Public benefits programs include energy efficiency, renewable energy, R&D, and low-income assistance activities.

Low-income households will benefit from cost-effective appliance efficiency standards or building energy codes. As pointed out by Stoft (1993), the U.S. Department of Energy has a tradition of not imposing standards with a simple payback period greater than three years for consumers on average. Since appliances have a lifetime of 15-20 years, there are significant net economic benefits for all households including low-income households. In fact low-income families living in rental property may benefit more than upper income families since they receive the energy bill savings but they do not pay the initial cost for space or water heating equipment, and in some cases refrigerators and other appliances. This is true throughout the OECD countries. Even if they move frequently, low-income families will benefit from appliance efficiency standards or building energy codes that result in higher levels of energy efficiency in the overall appliance and housing stock.

Summary

It is true that non-participants in utility DSM programmes may pay slightly higher energy prices and bills in the short run. But all customers will benefit in the long run as investments in new power plants or other capital-intensive energy supply facilities are avoided. Furthermore, the slightly higher bills that non-participants may pay in the short run are not adequate justification for eliminating DSM or other types of energy efficiency programmes. If these programmes reduce energy bills and provide benefits that exceed costs for customers as a whole (considering all benefits and costs), they are sound public policy. In addition, policy makers and utilities should give all customers the opportunity to participate and strive to maximise programme participation over a multi-year period in order to minimise any inequities.

There is little empirical evidence indicating that low-income households are especially penalised by energy efficiency policies and programmes. In fact, many national, state, or utility energy efficiency programmes dedicate a disproportionately large share of their resources towards serving low-income households. Also, appliance efficiency standards and building energy codes will especially benefit low-income households since they tend to get stuck with inefficient appliances and housing in the absence of energy codes and standards, as evidenced by the very high implicit discount rates observed for low-income households.

Having said this, policy makers and programme manager should ensure that low-income households as a whole receive a share of the benefits equivalent to or greater than their monetary contribution. Also, efforts should be made to serve as many low-income households as possible. Finally, if cross-sector subsidies are of concern to policy makers, energy efficiency programmes can be designed so that they are paid for and provide services within individual sectors.

F. Are Energy Efficiency Policies and Programmes as Effective as their Proponents Claim?

Proponents claim that energy efficiency policies and programmes can result in substantial and very cost-effective energy savings. Supporters of appliance efficiency standards in the U.S., for example, estimate that the standards reduced national electricity use 2.5% in 2000, that the savings will grow to nearly 8% of electricity use by 2020 as the appliance stock turns over, and the standards will result in

over \$180 billion in net economic benefits for consumers and businesses by 2030 (Geller, Kubo and Nadel 2001; Nadel 2002).

Regarding utility DSM programmes, Cavanagh (1995) stated, “Since the mid-1980s, such programmes have saved the equivalent of 80 large power plants, and contributed to the decade-long reduction in inflation-adjusted electricity bills throughout the U.S. economy. In California alone, the net value of verified utility-financed efficiency improvements exceeded two billion dollars between 1990 and 1993.”

Some energy efficiency critics argue that energy efficiency programmes are much less cost-effective in saving energy than proponents claim. Joskow and Marron (1992) reviewed demand-side management (DSM) programmes implemented by ten utilities in the early 1990s and found that some utilities failed to report all programme or customer costs and that many utilities based their cost-effectiveness analysis on engineering estimates of energy savings. They pointed out that *ex post* impact evaluations tend to show less energy savings than *ex ante* engineering projections. Furthermore, they found that a number of utilities ignored “free rider” effects in their analysis of net programme impacts and cost-effectiveness.¹⁰ Combining these factors, Joskow and Marron hypothesised that utilities in general are underestimating the cost of energy savings from their DSM programmes by at least a factor of two (Joskow and Marron 1992).

Other critics suggest that regulatory policies can lead utilities to operate DSM programmes that lead to little or no real energy savings (Wirl 2000). The contention is based on the observation that under traditional regulatory rules where rates (the price charged per kW or kWh) are fixed at any particular time, energy savings will reduce a utility’s revenues and profits in the short run. Thus, requiring utilities to implement DSM programmes does not necessarily motivate them to operate effective programmes.

Response

The issues raised here by the critics are legitimate. It is important to use empirical data, not engineering estimates alone, to determine the actual energy savings resulting from energy efficiency programmes. Likewise, it is important to analyse the full costs and benefits of utility DSM programmes and other types of energy efficiency initiatives. But taking into consideration the vast experience with energy efficiency policies and programmes, it is not accurate to conclude that energy efficiency policies and programmes in general are ineffective or uneconomical.

Levine et al. (1995) point out a number of flaws in the Joskow and Marron analysis. Some of the programmes covered by Joskow and Marron were pilot programmes or specialised programmes for low-income households; both can have above-average costs per unit of energy savings. Other studies of large-scale utility DSM programmes, in many cases using measured rather than estimated savings data, have found that these programmes in fact save energy and are cost-effective. A review of 40 large-scale commercial sector DSM programmes implemented during the early 1990s found that they saved electricity at an average cost of \$0.032 per kWh, well below the cost of supplying electricity no

¹⁰ “Free riders” are programme participants who would have purchased and installed an energy efficiency measure even in the absence of the programme.

matter what the fuel source (Eto et al. 1995). This study relied on post-programme evaluations of energy savings, and included all utility costs as well as customer costs in its analysis.

A more recent review of the cost-effectiveness of utility DSM programmes in the U.S. found similar results — an average cost of saved energy of \$0.03 per kWh and an average benefit-cost ratio of about 2.3 (Kushler, York and Witte 2004). Likewise a review of lighting efficiency programmes in Europe found that the average cost of saved energy was just \$0.021 per kWh (Mills 1991). However, there is variation among types of programmes, e.g. DSM programmes for commercial and industrial customers tend to be more cost-effective than those for residential customers.

The state-of-the-art in utility DSM programme design and evaluation has improved considerably over the past 20 years. Many utility DSM programme evaluations today consider the “free riders” and in some cases the “free drivers” associated with the programme. The “free drivers” or spillover effect refers to those who adopt efficiency measures because of a programme but without participating in the programme. Free drivers result from increasing the awareness and availability of efficiency measures, for example.

Some analysts have used econometric techniques to isolate the energy savings attributed to utility DSM programmes from energy price, economic growth and weather impacts. Parfomak and Lave (1996) examined the energy savings impacts of 39 utility DSM programmes for commercial and industrial customers in this manner. The utilities reported that their cumulative DSM efforts reduced commercial and industrial electricity use by 4.9% on average. Parfomak and Lave found that over 99% of the reported energy savings are in fact statistically observable after accounting for changes in energy price, income growth, and weather effects. The authors conclude, “The results of this study show that utility conservation programmes have been effective in reducing electric loads and that utilities have been reporting these reductions accurately” (Parfomak and Lave 1996).

Loughran and Kulick (2004) examined changes in state electricity use as a function of energy prices, economic output, climate, and utility DSM expenditures in the U.S. during 1991-99. They found that DSM programmes do save electricity, but less than the utilities claimed, and at a higher cost of saved energy than often claimed. They also found that utilities with a strong commitment to DSM saved electricity more cost-effectively than utilities with a weak commitment. Loughran and Kulick (2004) conclude, “While the evidence presented in this study indicates that DSM expenditures in aggregate have done less to improve the electricity efficiency of the U.S. economy than what utilities themselves estimate; it may be that, from a societal standpoint, these DSM expenditures are nonetheless worthwhile.”

It should be noted that Loughran and Kulick estimated first-year energy savings only, not energy savings over the lifetime of efficiency measures.¹¹ Thus, their cost of saved energy estimates are not based on the full benefits of energy efficiency investments. Consequently, it is inappropriate to judge whether or not utility DSM programmes have been cost-effective based on their study.

The fact that utilities do not necessarily have an incentive to implement effective energy efficiency programmes is noted as one of the barriers to greater energy efficiency in section G. Because of this

¹¹ This flaw was acknowledged by David Loughran in an email exchange with Howard Geller, 3 May 2005.

problem, some U.S. states provide investor-owned utilities with financial incentives for operating effective energy efficiency programmes (Stoft, Eto and Kito 1995; Kushler, York and Witte 2004). Real world experience demonstrates that utilities tend to invest more in energy efficiency measures if they are given such incentives (Sioshansi 1994; Carter 2001).

Energy efficiency policies and programmes are not always a success. In the U.K., electric utilities have been distributing compact fluorescent lamps (CFLs) free of charge. Millions of CFLs have been given away, but this has discouraged purchase of these energy-efficient products in the marketplace. Consequently, retail stores have reduced their stocking and promotion of CFLs, creating a vicious circle (Boardman 2005).

The U.S. federal government provided tax credits for energy efficiency measures purchased by households and businesses in the late 1970s and early 1980s. The credit amounted to 15% of the measure cost for households and 10% of the measure cost for businesses. Studies were not able to document that the tax credits expanded the adoption of energy efficiency measures (Carpenter and Chester 1984; Peterson 1985). This result was attributed to the small size of the credits and the fact that credits were offered for commonplace efficiency measures such as home insulation and weatherstripping, measures that were widely adopted before the credits took effect. These tax incentives cost the U.S. Treasury around \$10 billion and were discontinued in 1985. As a result of this experience, some energy efficiency proponents in the U.S. now advocate tax incentives for innovative technologies such as hybrid gas-electric and fuel cell vehicles, highly-efficient new homes and commercial buildings, and super-efficient appliances (Quinlan, Geller and Nadel, 2001).

Evaluations of residential retrofit programmes carried out in the U.S. in the 1970s and 1980s generally found that actual energy savings were much less than *ex ante* engineering estimates (Sebold and Fox 1985; Nadel and Keating 1991; Fels and Keating 1993). This discrepancy was attributed to poor installation of efficiency measures, human behaviour effects (including the rebound effect discussed above), and inaccurate engineering estimates of savings potential.

Analyses such as those mentioned above prompted energy efficiency researchers and practitioners to improve energy audit and home retrofit techniques during the past 30 years. Improvements included instrumented home energy audits and effective methods for sealing the air leaks in a building envelope as well as the air ducts used for heating and cooling. These innovations resulted in more energy savings and more cost-effective policies and programmes. The national weatherisation programme for low-income households, for example, lowered space heating energy consumption in participating households by around 30% on average during 1993-2002 based on evaluation of actual results, not engineering estimates (Berry and Schweitzer 2003). This is much greater than energy savings realised under this programme during the 1970s and 1980s.

Energy efficiency practitioners also have improved information and audit programmes for commercial and industrial enterprises. In general, programmes have evolved from providing general information to more detailed information that is of practical value to individual companies. For example, a review of energy audit and information programmes for businesses in Australia states, "Programmes which assist companies in obtaining and utilising specific information may be a cost-effective way of changing business practices. Further, the long history of government involvement in such programmes has led to considerable improvement in their effectiveness" (Productivity Commission 2005).

Regarding appliance efficiency standards, market research has shown that the incremental cost for more efficient products predicted in advance of the adoption of standards is in fact often overstated (Nadel 2002). In the case of refrigerators, the average retail price actually declined rather than increased after appliance efficiency standards took effect in both the EU and the United States (Greening, Sanstad and McMahon 1997; Boardman 2004). Once forced to improve energy efficiency and do so across the board, manufacturers figure out less costly ways of meeting the standards. This means that the net economic benefits of appliance efficiency standards have been greater, not less, than analysts originally estimated.

Some energy efficiency efforts have transformed the market for energy efficiency measures in a particular country or region, making them especially cost-effective. For example, a Swedish programme implemented during 1988-98 accelerated the introduction and market penetration of high efficiency refrigerators, clothes washers and dryers, high performance windows, more efficient computer equipment, and electronic lighting ballasts (Neij 2001). In the U.S., energy efficiency programmes have had an especially large impact on the adoption of resource-efficient clothes washers, high efficiency air conditioners and heat pumps, and high efficiency exit signs and traffic signals (Nadel et al. 2003). Market transformation is often achieved through a combination of technology R&D, commercialisation support, financial incentives, consumer education, and efficiency codes and standards (Geller and Nadel 1994; Nadel et al. 2003; Boardman 2004).

In the U.K., building efficiency regulations, grant schemes, and equipment labelling and standards implemented starting in the mid-1970s reduced total energy use in housing by approximately 14% as of 2001 (Shorrocks 2005). Building regulations, which were adopted in 1965 and updated five times since then, were responsible for about half the energy savings (see Figure 4). More recently, labelling and minimum efficiency standards have increased the efficiency of major appliances (refrigerators, freezers and clothes washers) as well as space heating systems. This experience shows that it takes time for energy savings to accumulate and that it is critical to update policies such as labelling schemes and efficiency regulations periodically (Shorrocks 2005).

Some types of energy efficiency policies and programmes result in important non-energy benefits as well as energy savings. Home retrofit programmes can increase occupant comfort and health, reduce pollutant emissions, and increase the capability of low-income households to pay their energy bills. Valuing these non-energy benefits can significantly increase the cost-effectiveness of the programmes (Brown et al. 1993; Clinch and Healy 2001). In fact, some studies have found that the value of non-energy benefits can exceed the energy benefits by a factor of two or more (see Box 1). If these non-energy benefits are ignored or not factored into cost-benefit analyses, energy efficiency programmes will appear to be less attractive than they really are.

Intensive energy efficiency efforts have also proven to be an effective strategy for dealing with temporary electricity supply shortages in a number of countries. In Norway, New Zealand and California, there were significant increases in energy prices along with programmes to accelerate efficiency improvements and behavioural changes. But in Tokyo, Ontario and France, there was no mechanism for raising prices quickly. Accelerated efficiency efforts and conservation alone prevented power outages when these jurisdictions confronted temporary electricity shortages (IEA 2005).

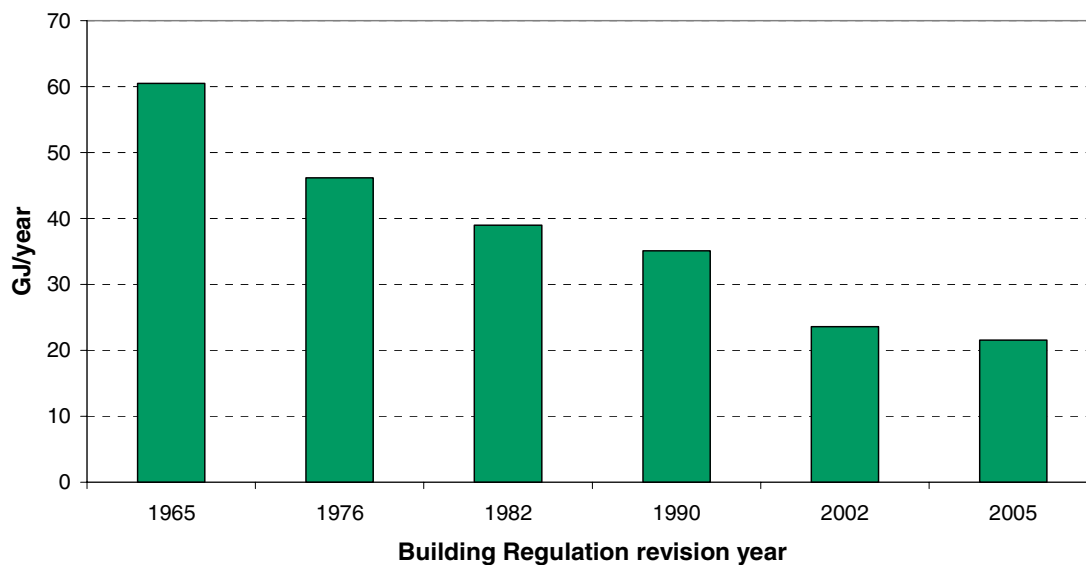


Figure 4. Evolution of building regulations in the UK — energy use for space and water heating of typical new dwellings (Shorrock 2005)

Box 1: Non-Energy Benefits of Energy Efficiency Programmes: Some Examples

Low-Income Housing Retrofit Program – California

The non-energy benefits of a low-income housing weatherisation and education programme implemented by Pacific Gas & Electric Company in California were analysed in 1998 (Skumatz and Dickerson 1998). This study estimated that the non-energy benefits were worth \$305 per year, 2.4 times the value of the direct energy savings. The main non-energy benefits were reduced water and wastewater costs, fewer energy terminations, improved quality of the housing stock, and fewer illnesses. The study also provided recommendations on how the utility could maximise these non-energy benefits such as by targeting the programme to households in arrears on their utility bill payments or occupying older housing.

Energy Efficiency Incentives Program for Businesses – Wisconsin

The non-energy benefits of an energy efficiency incentives programme for businesses in Wisconsin were analysed through interviews with 74 programme participants (Hall and Roth 2003). Over 70% of participants reported that the installation of energy efficiency measures reduced maintenance costs and improved employee morale. And 30-50% of participants reported that the measures improved productivity, increased equipment life, or reduced waste generation. The researchers estimated that the overall non-energy benefits resulting from the installation of energy efficiency measures were worth \$17 300 per year on average, 2.5 times the value of the direct energy savings. This analysis included estimates by companies of both increased and decreased non-energy costs.

Summary

Some energy efficiency policies and programmes such as energy conservation tax credits and home retrofit efforts implemented in the U.S. during the 1970s and 1980s did not appear to be successful in stimulating significant net energy savings or economic benefits. However, energy efficiency strategies

have evolved over time. Home retrofit programmes such as the U.S. weatherisation programme for low-income households are much more effective today compared to programmes 20-30 years ago. In addition, the empirical evidence indicates that utility DSM programmes and appliance efficiency standards in general do result in cost-effective energy savings.

Policy makers and energy efficiency proponents should learn from past experience and correct any policy or programme shortcomings that exist today. In particular, policy makers and energy efficiency practitioners should keep policies and programmes up-to-date, consider providing performance incentives for utilities or other energy efficiency programme administrators, and analyse the full costs and benefits of energy efficiency policies and programmes, including the non-energy benefits. The issue of policy and programme evaluation is discussed in detail in section H below. Moreover, policy makers should strive to integrate different policies into comprehensive market transformation strategies.

G. Are the Market Failures that are used to Justify Energy Efficiency Policies and Programmes Mostly a Myth?

Energy efficiency proponents point to a wide range of market failures or barriers in order to justify energy efficiency policies and programmes. These market barriers and failures include:

- ❖ the limited supply and availability of relatively new energy efficiency measures in the marketplace;
- ❖ consumers lacking or having incomplete information about energy efficiency options;
- ❖ some consumers lacking the capital to invest in energy efficiency measures;
- ❖ fiscal or regulatory policies that discourage energy efficiency investments;
- ❖ misplaced incentives whereby the party designing, constructing or purchasing a building or piece of equipment, or the landlord in rental property, generally seeks to minimise first cost rather than lifecycle cost;
- ❖ consumers or businesses paying little attention to energy use and energy savings opportunities if energy costs are a small fraction of the total cost of owning or operating a home, business or factory; and
- ❖ energy prices that do not reflect the full costs imposed on society by energy production and consumption.

Energy efficiency proponents call these market barriers and failures as a whole the energy efficiency “gap”, referring to the difference between levels of investment in energy efficiency that appear to be cost-effective based on engineering-economic analysis and the levels actually occurring (Golove and Eto 1996). Policies and programmes such as energy efficiency standards, financing and incentive schemes, or training and education programmes are advocated in order to reduce the energy efficiency “gap”.

Some critics argue that not all of these market failures or barriers are problems that should be overcome or can be overcome cost-effectively. They argue that at least a portion of the energy efficiency “gap” is justifiable, i.e. evidence of well-functioning markets or legitimate transaction costs. They point out that consumers lack perfect information about many subjects, not just energy efficiency measures (Jaffe and Stavins 1994). Some critics note that there is uncertainty about future energy

prices and the benefits that investments in energy efficiency measures will provide; therefore it is reasonable for households or businesses to expect a higher rate of return (i.e. use a higher “hurdle rate”) for energy efficiency measures compared to other investment opportunities (Taylor 1993; Jaffe, Newell and Stavins 1999). Hasset and Metcalf (1993) also point out that an energy efficiency investment is illiquid, consequently they believe consumers are justified in demanding a higher rate of return.

The heterogeneity of consumers is presented as another justification for the energy efficiency gap. This critique observes that while a technology may be cost-effective on average, it is not necessarily cost-effective for all consumers (Golove and Eto 1996). In addition, some critics claim that it is logical for some consumers or businesses to postpone energy efficiency investments because technologies tend to improve over time and greater energy savings and economic returns may be realised by delaying investment (Sutherland 2000).

Some energy efficiency critics also point out that consumers or businesses may perceive (rightly or wrongly) that energy efficiency technologies do not perform as well as standard, less efficient products they are used to. For example, consumers may believe that energy-efficient fluorescent lamps provide poorer quality light compared to incandescent lamps, that energy-efficient homes have poorer air quality and are less healthy than leaky, inefficient homes, or that energy-efficient furnaces or air conditioners are less reliable than “low tech” standard efficiency models (Jaffe and Stavins 1994).

Critics also have questioned the environmental and social externalities associated with energy production and use. Taylor (1993), for example, states that environmental compliance costs may be greater than environmental damages caused by energy consumption. If this is the case, then consumers are already paying energy prices that reflect the environmental externalities. Taylor also argues that saving energy does not necessarily provide significant environmental or social benefits. He notes that electricity conservation efforts over the long run would avoid newer, cleaner power plants, not necessarily reduce the operation of older, higher polluting plants. Also, he argues that the economic externalities associated with high oil import dependence, and periodic oil price shocks, are mostly a myth (Taylor 1993).

Response

First, it is important to recognise there is no single market for energy efficiency. The energy efficiency “market” consists of hundreds of end-uses, thousands of intermediaries, and millions of consumers (Golove and Eto 1996). Second, it is useful to distinguish between what are generally viewed as market failures and market barriers, as indicated in Table 2. Market failures occur if there is a flaw in the way markets operate. Market barriers are not market failures, but limit the adoption of energy efficiency measures nonetheless.

Table 2. Market Failures and Market Barriers Inhibiting Greater Energy Efficiency

Market failures	Market barriers
Unpriced costs and benefits	Low priority of energy issues
Distortionary regulatory and fiscal policies	Incomplete markets for energy efficiency
Misplaced incentives	Capital market barriers
Insufficient and inaccurate information	

Sources: Brown 2001.

Some critics have acknowledged that there are market imperfections that lead to suboptimal investments in energy efficiency in the real world. Jaffe and Stavins (1994), for example, recognise that environmental externalities represent a real barrier to energy efficiency. They state, “While much controversy surrounds the magnitude of the value of the environmental damages associated with energy use, the direction of the effect is unambiguous. Whether or not there is a paradox, consumers face incentives to use more energy than is socially desirable if they do not bear the full costs of the pollution their energy use fosters.”

Estimates of these environmental damages vary in magnitude. Analysts in Europe concluded that power plant emissions cause about \$70 billion of harm to human health, crops, and buildings in the European Union annually (Krewitt et al. 1999). This is equivalent to \$0.045/kWh, or about half the average retail electricity cost. In the U.S., one major study concluded that the environmental costs associated with power plant emissions were about \$0.01/kWh for gas-fired power plants and \$0.03-0.07/kWh for coal-fired power plants (Pace University 1990). For the latter, externality costs depend on the type and age of the power plant. However, another more recent study concluded that the total damage cost is lower — only about 10% of the direct market cost of energy (Gillingham, Newell and Palmer 2004). Regardless of the magnitude, these “environmental externalities” are not included in the electricity prices paid by consumers.

There are various types of fiscal or regulatory policies that discourage investments in energy efficiency. In the United States, capital investments in commercial buildings must be depreciated over more than 30 years, while energy purchases can be fully deducted from taxable income the year they occur (Brown 2001). This means that tax policy discourages energy efficiency improvements. Likewise, regulatory policy that allows public utilities to increase their profits by selling more electricity or natural gas is a disincentive to effective utility energy efficiency programmes (Carter 2001). Also, vehicle fuel efficiency policies have encouraged the shift towards less efficient sport utility vehicles (SUVs).

Misplaced incentives, also known as split incentives, exist in rental markets where building owners are responsible for investment decisions but tenants pay the energy bills. A number of studies have revealed higher implicit discount rates (i.e. lower levels of energy efficiency) in dwellings occupied by renters compared to those occupied by owners in the United States (Train 1985). In addition, it is generally believed that insulation, energy-efficient windows, programmable thermostats, and other energy efficiency measures are less common in rental housing compared to owner-occupied dwellings. A recent survey in California confirmed this belief (see Figure 5). Misplaced incentives are also found

in construction markets where decisions about building design and features are made by people not responsible for paying the energy bills (Brown, Southworth and Stovall 2005).

Sanstad and Howarth (1994) point out that there is a large body of research documenting that consumers are often poorly informed about technology characteristics and energy efficiency opportunities. Likewise, consumers often lack the ability or time to process and evaluate the information they do have, a situation sometimes referred to as “bounded rationality” (Golove and Eto 1996). For example, consumers often have difficulty using information on energy labels or in calculating the payback period for a more efficient appliance (Sanstad and Howarth 1994). Consumers may know how much more an energy-efficient air conditioner or water heater costs, but they do not know how much they will save per year by purchasing the more efficient technology. Greene (1998) makes similar arguments with respect to vehicle purchases, as does Ostertag (2003) regarding high efficiency motors in Europe.

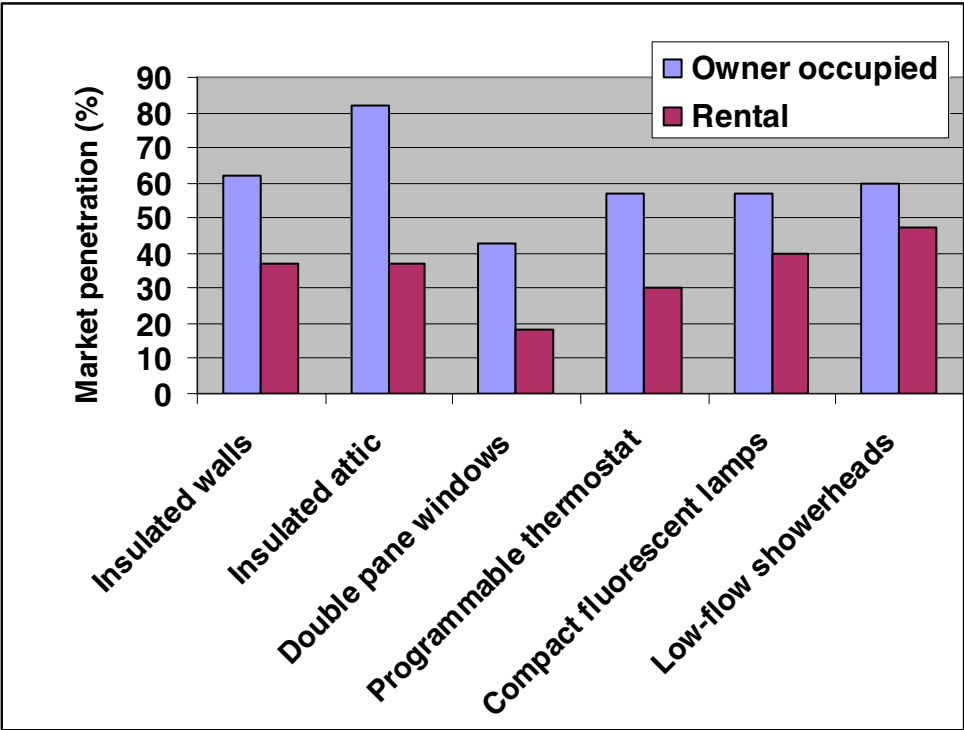


Figure 5. Comparison of the market penetration of energy efficiency measures in owner-occupied and rental housing in California (CEC 2004)

Turning to the market barriers, energy costs often account for a very small fraction of the total cost of owning and operating a business, building, or vehicle. In the office space market in London, for example, energy costs are equivalent to 1-2% of rental costs (Guertler, Kaplan and Pett 2005). In Australia, energy costs represent about 2.5% of total expenditures in the residential sector, 1.6% of total expenditures in the commercial sector, and less than 3% of total expenditures in many (but not all) industrial sectors (Productivity Commission 2005). If energy costs are low relative to other costs, it discourages households or businesses from seeking or pursuing energy savings opportunities.

Many consumers or businesses do not value the lifetime energy savings provided by more efficient appliances, vehicles, or other energy efficiency measures. In the United States, studies indicate that

consumers on average expect vehicle fuel efficiency improvements to pay back their first cost in three years or less even though vehicles remain in use for about 14 years on average (Greene and Schafer 2003). Likewise many businesses will not invest in energy efficiency measures with a payback period exceeding three years (DeCanio 1993). This barrier leads to underinvestment in energy efficiency, increased energy consumption, and increased CO₂ emissions compared to what is optimal from a societal perspective.

Detailed studies of particular markets have found multiple and substantial market failures and barriers inhibiting the adoption of seemingly cost-effective energy efficiency improvements. Golove and Eto (1996) documented these multiple market failures and barriers for the new construction and the commercial building HVAC and lighting retrofit markets in the United States.

A study of the motors market in France found that motor suppliers often fail to stock high efficiency motors, buyers lack accurate information on motor energy efficiency, and many motors are replaced on an emergency basis resulting in little or no time to consider energy efficiency. Also, the majority of motors are purchased by so-called Original Equipment Manufacturers (OEMs), companies that assemble pumps, blowers, air conditioning systems, etc. OEMs in France (and elsewhere) generally purchase motors based on lowest first cost since they are not responsible for paying the energy costs. As a result of all these factors, the market share for high efficiency motors in France in the mid-1990s was less than 1% even though the payback on the extra first cost for a high efficiency motor was typically two years or less in moderate or high usage applications (de Almeida 1998).

An in-depth survey and econometric study was carried out to assess the magnitude of different barriers to energy efficiency improvements in 3 000 commercial and industrial facilities in Germany. The project also examined the effectiveness of energy audits in overcoming these barriers. This research confirmed the existence of various barriers including lack of information, lack of time, and other investment priorities. It found, for example, that small and medium-size companies and those with relatively low energy intensity lack expertise and tend to devote little time or effort to pursuing energy efficiency. Also, owners and occupants of rented buildings invested less in energy efficiency than those in owner-occupied buildings. The study found that energy audits tend to reduce all of the barriers to energy efficiency, although audits conducted by engineering firms were most effective (Schleich 2004).

On a more theoretical level, Sanstad and Howarth (1994) note that “the view that the system of private enterprise produces optimal outcomes as a rule is very imperfectly supported by the theorems of welfare economics.” They conclude that energy efficiency critics who claim that there are no valid market imperfections are expressing a libertarian political ideology, not one that stands up to empirical scrutiny. Other economic perspectives, such as transaction cost economics and behavioural economics, recognise barriers such as bounded rationality, imperfect information, and limitations to market transactions (Golove and Eto 1996; Sorrell 2004).

Summary

Market failures and barriers to investment in energy efficiency are well-documented in the energy efficiency literature. Many studies have analysed and confirmed the existence of market failures including misplaced (split) incentives, insufficient information, and costs that are not reflected in

energy prices, such as the environmental and health damages associated with energy production and use. Likewise, market barriers such as the low priority many consumers and businesses place on reducing energy costs through energy efficiency improvements are also well-documented. Policy makers should recognise that these market failures and barriers exist, analyse their importance in particular markets, and consider policies and programmes to remove or overcome them.

It is true that there are costs associated with removing or overcoming market failures or barriers, e.g. for educating consumers, addressing the split incentives problem, or convincing households or businesses to invest in energy efficiency to a greater degree. Policy makers should strive to reduce these transaction costs and ask the following questions: Are policy and programme interventions cost-effective mechanisms for stimulating greater investment in energy efficiency measures? In other words, do the benefits of the policy or programme — the net present value of the energy savings, peak demand reduction and non-energy benefits — exceed the costs of the energy efficiency measures as well as the policy or programme interventions? If the answers are yes, then the policy or programme deserves support.

H. Is it Possible to Measure or Accurately Estimate the Energy Savings Resulting from Energy Efficiency Policies and Programmes?

Measuring energy savings from energy efficiency policies or programmes differs from measuring energy supply from a power plant, oil refinery, or gas pipeline. In most cases, it is not possible to directly measure energy savings. However, energy efficiency programme managers and analysts have developed and refined various techniques for estimating energy savings. These techniques include measuring “before and after” energy consumption in a sampling of programme participants, statistical analysis of energy bills, surveys of programme participants and non-participants, and analysis of market trends.

Some energy efficiency critics contend that it is not possible to evaluate the energy savings impacts of energy efficiency policies and programmes. Inhaber (1997, p. 105) states, “Getting a handle on what conservation programmes have achieved is not simple, and often close to impossible. If consumers boost their electricity use by 3% and the utility had previously estimated a 4% increase, is the conservation programme a success? The 3% is a real figure, but the 4% is predicated on a host of assumptions, some buried in computer software.”

Response

There is a wide body of experience concerning the evaluation of the energy savings, peak demand reduction, and cost-effectiveness of energy efficiency programmes. In 1995, the International Energy Agency published a handbook on energy efficiency programme evaluation (Violette 1995). A European guidebook on energy efficiency programme evaluation was released in 2001 (SRCI 2001). In addition, many countries make use of an International Performance Measurement and Verification Protocol to analyse the energy savings of individual energy efficiency projects (IPMVP 2003).

Energy programme evaluation is not an exact science. There are different ways of estimating energy savings, some more sophisticated and some less so. But there are some basic principles that permeate energy efficiency programme evaluation. These include making critical post-installation field

measurements, analysing utility billing data including normalising for variations in weather or output where appropriate, estimating “free riders” and net energy savings, and taking into account measure and savings persistence. All these concepts are well-established and widely used to estimate the energy savings and cost-effectiveness of energy efficiency programmes. Box 2 provides some real-world examples of energy efficiency programme evaluation.

Box 2: Examples of Energy Efficiency Programme Evaluations

Technical Assistance Program – Canada

The Canadian Industry Program for Energy Conservation (CIPEC) is a long-standing effort aimed at reducing energy waste by industries. The programme encourages companies to set savings targets and provides support through workshops, guidebooks, benchmarking studies, financial assistance for audits, and newsletters. Also, the programme develops partnerships with industry trade associations. In 2002, a telephone survey of 1 223 companies was carried out including both programme participants and non-participants. The survey was combined with data on five-year change in energy consumption for each facility. Statistical analysis of the data showed that energy use of participants increased 2.2% on average over the five-year period, compared to a 5.2% average increase for non-participants (Westfall, Nanduri and Taylor 2003). Energy use of each company was adjusted to take into account changes in company size or production.

Industrial Energy Efficiency Improvement – The Netherlands

The Netherlands established a long-term agreements programme with industries representing over 90% of industrial energy use. Participating companies agreed to develop and implement energy efficiency improvements, with the government providing technical and financial assistance. Also, the government agreed to protect participating companies from any new energy efficiency regulations. Covered industries increased their energy efficiency over 20% on average between 1989 and 2000, surpassing their targets in most cases (Van Luyt 2001). However, one analysis concluded that the long-term agreements probably only stimulated 25-45% of the energy savings achieved by industries during this period (Reitbergen, Farla and Blok 1998). The remainder of the savings is attributed to autonomous efficiency improvements (savings that would have likely occurred anyway) and structural changes. Even with this savings adjustment, the long-term agreements programme was a cost-effective strategy for promoting energy savings (Reitbergen, Farla and Blok 1998).

Home Energy Retrofit Programmes – United Kingdom

In the United Kingdom, the government has provided grants to stimulate energy efficiency improvements in housing for decades. Shorrocks (1999) found that the programme was cost-effective in saving energy even after accounting for free rider effects, the impact of changing energy prices, and the degree to which efficiency improvements were used to improve comfort, i.e. the so-called rebound effect. Accounting for free riders reduced the net energy savings of the programme by about 40%, leading to net savings of about 31 PJ per year as of 1996 from loft (attic) insulation alone. Even with this adjustment, the loft insulation grant programme saved households £2.55 billion cumulatively during 1978-96, while costing the government and participants £1.23 billion (Shorrocks 1999).

To be fair, the energy efficiency literature provides many examples of policies or programmes that were not thoroughly evaluated. A new database on best practices in energy efficiency programmes in the United States points out that some programmes still do not track basic performance indicators such as *ex post* energy savings, cost of saved energy, or market penetration (Quantum Consulting 2004). In the U.K., there has not been thorough evaluation of the net energy savings achieved by the Energy

Efficiency Commitment programme (CPA 2005). Also, there is a paucity of studies that decompose savings into programme effects, price effects and autonomous efficiency gains.

Techniques for energy efficiency policy and programme evaluation are evolving and maturing. In California, the California Measurement Advisory Council (CALMAC) maintains and periodically updates detailed energy efficiency programme evaluation procedures. CALMAC also serves as a forum to develop, implement and review energy efficiency programme evaluations. A wide range of energy efficiency programme evaluations are published and available on their website, www.calmac.org. California utilities typically spend 5-10% of their total DSM budget on programme evaluation, more than most other utilities spend. These expenditures are included in the analysis of programme cost-effectiveness.

In Europe, energy savings measurement and evaluation is now being discussed in the context of the adoption of national energy savings obligations by some countries, e.g. Belgium (Flanders), France, Italy and the U.K., as well the Proposed EU Directive on the Promotion of Energy Efficiency and Energy Services. This proposal, issued by the European Commission on December 2003, calls for mandatory energy savings targets among all EU member states. The issues raised by this proposal include the degree to which detailed “bottom-up” savings evaluation will be required, how to establish baselines, the level of harmonisation of savings evaluation across countries, and the cost and administrative burden associated with savings evaluation (Lees 2005; Thomas 2005b).

Energy efficiency programme evaluation by nature is a trade-off between careful measurement and analysis on the one hand and simplicity and cost minimisation on the other. It is not feasible or cost-effective to monitor or analyse in detail every energy efficiency project or measure. After decades of experience, many energy efficiency programme managers and evaluators have learned how to balance this tension and produce reasonably accurate estimates of energy savings at an acceptable cost. Thomas (2005b) states, “Experience, e.g. in the UK and Denmark also shows that joint efforts for harmonised bottom-up evaluation methods can lead to pragmatic approaches with reasonable accuracy and very modest cost.”

Summary

Energy efficiency critics are correct in pointing out that it is very difficult to measure precisely the energy savings resulting from energy efficiency policies and programmes. But a wide range of evaluation techniques has been developed and refined over the past 30 years to estimate energy savings with acceptable levels of precision. These techniques include direct measurements of “before and after” savings, estimation of “free riders” and net savings through surveys of participants and non-participants, and utility billing analysis with adjustments for variations in weather or output where appropriate. Policy makers should ensure that all energy efficiency initiatives are evaluated using these state-of-the-art techniques.

Experience has shown that it is possible to carry out thorough analysis of energy savings impacts at an acceptable cost, without compromising the cost-effectiveness of the policy or programme. Nonetheless, some energy efficiency programmes still lack “good practice” energy savings

evaluations. Where this is the case, policy makers and those responsible for programme implementation should correct this shortcoming.

I. Is Energy Efficiency a Failure Because Energy Use has been increasing in OECD Countries?

Energy efficiency proponents tend to use a “bottom-up” approach to estimate the energy savings associated with particular energy efficiency measures. Energy savings are aggregated across measures to estimate the national or regional savings from policies such as appliance efficiency standards, utility DSM programmes, consumer education efforts, or combinations of policies and programmes (Energy Innovations 1997; Webber, Brown and Koomey 2000; Geller, Kubo and Nadel 2001; Geller 2003).

Some energy efficiency critics argue that energy efficiency improvements at the microeconomic level lead to higher levels of energy consumption at the macroeconomic level. In essence these critics claim that energy efficiency improvements increase productivity and reduce the cost of energy services such as the cost of travel or of motive power for industry, thereby leading to an increase in the demand for these energy services. Over the long run, this results in an increase rather than decrease in total energy consumption according to critics such as Brookes (1992), Saunders (1992), Herring (2004), and Huber and Mills (2005).

A few critics claim that rising energy consumption in OECD countries in the past 30 years is evidence that energy efficiency efforts result in increased rather than decreased energy use. Huber and Mills (2005, pp. 108-109) state, “And it seems obvious that rising efficiency in cars, furnaces, and lawn mowers should, in the aggregate, significantly curb demand for energy. Sad to say, however, the chronicles of light discussed in the preceding chapter reflect a much broader truth: efficiency does not lower demand, it raises it.”

The heart of this argument is that new energy-efficient technologies open up new applications that increase economic output and/or standards of living, and that these “growth effects” overtake the direct energy savings sooner or later. Huber and Mills (2005, p. 107) review the history of engines, lighting, and solid-state electronics and conclude “...when radically more efficient technologies do emerge, they are quickly embraced...embraced not just to displace old ways of doing things, but to do all sorts of new things that previously hadn’t been done at all. Which means, at the very least, that rising efficiency certainly does not guarantee falling energy consumption.”

Even some environmental advocates fault energy efficiency efforts for not reducing overall energy consumption. Rudin (2000), for example, claims that U.S. energy efficiency efforts have failed on this basis and therefore should not be continued or promoted to other countries. He states, “These three examples of office buildings, automobiles, and demand side management failed to lower energy use. One would think their failure would limit their popularity, but that has not been the case.” Rudin argues for promoting behaviour and lifestyle changes that will reduce absolute energy consumption over time, rather than increasing the energy efficiency of buildings, appliances and vehicles.

Some European analysts have also criticised energy efficiency efforts for not halting growth in demand for energy services and energy, and thus not adequately protecting the environment or ensuring sustainability. Throne-Holst (2005), for example, points out that the growing average floor

area of homes, growth in appliance purchases and saturation, and the trends toward more powerful cars and more vehicle use are contributing to rising energy consumption in most European countries. Herring (2004) calls for behavioural changes and in particular argues for higher energy or CO₂ taxes to stimulate reduced consumption.

Lebot et al. (2005) and Boardman (2005) point out that some energy efficiency policies have inadvertently encouraged bigger or more energy-intensive homes, appliances and cars. For example, it is easier for larger appliances to earn a high energy efficiency rating in Europe. Also, standby electricity consumption is often not included when testing the energy performance of an appliance, thereby discouraging low standby power levels. In the United States, flaws in the national vehicle efficiency standards have encouraged the shift to inefficient SUVs and pickup trucks (NAS 2001). In addition, some policies have been criticised for encouraging efficiency at the point of energy use but not necessarily from a total resource (primary energy) perspective (ASE 1998). This approach can encourage greater use of inefficient electric resistance heating.

Wilhite and Norgard (2003) argue that, “a new policy paradigm is needed for Europe and other rich countries of the world, one that aims at *sufficiency in energy services*.” They believe that it is essential to reduce absolute energy consumption in order to achieve long-term sustainability including meeting the Kyoto Protocol targets and limiting global warming to acceptable levels. To do so, they advocate policies to change behaviour and discourage what they deem as over-consumption, e.g. to lower the demand for more and ever bigger cars, homes, appliances, etc. Lebot et al. (2005) echo these sentiments.

Response

It is true that both final and primary energy use have continued to increase in the industrialised countries in the past 30 years in spite of expanded energy efficiency efforts. But it is not well-established that widespread energy efficiency improvements in appliances, vehicles, buildings, etc. actually resulted in a net increase rather than decrease in overall energy use.

Herring (2004) and Huber and Mills (2005) linked improving end-use energy efficiency with rising demand for energy services and increased overall energy use. They did not, however, rigorously analyse and demonstrate that improving energy efficiency caused the growth in energy use. In reality many factors including rising labour input and productivity, better education, advances in knowledge and technology, rising capital input and productivity, and economies of scale stimulate income growth and consequently greater demand for energy services (Denison 1985; Grübler 1998). It is incorrect to conclude that all the growth in energy use in recent decades was due to energy efficiency improvements alone.

This criticism is related in part to the magnitude of the direct and indirect rebound effects discussed in sections A and B above. The conclusion in those sections is that the rebound effects are real but relatively minor in magnitude by and large. This is especially true for the indirect economy-wide rebound effect. Most of the immediate energy savings from the adoption of more energy-efficient end-use technologies remain after secondary behavioural and macroeconomic adjustments occur.

A number of analysts have examined the question of how much energy use would there have been had energy efficiency improvements in a particular sector, country, or group of countries not occurred. Bosseboeuf and Richard (1997), for example, analysed the situation in France and concluded that final energy demand responding to socio-economic pressure alone would have risen by 47 Mtoe during 1973-93. However, over the same period, energy efficiency and conservation efforts resulting from government policies and market forces saved 33 Mtoe, equivalent to 25% of actual final energy demand in 1993.

Shorrock (2003) examined how different factors affected energy use and CO₂ emissions associated with energy use in housing in the U.K. during 1970-2001. He found that reductions in building envelope heat loss and improvements in heating system efficiency during this 31-year period, both of which received substantial government support, lowered energy consumption substantially. If these efficiency improvements had not occurred, total carbon emissions associated with energy use in housing would have been nearly 85% greater than they actually were in 2001.

The IEA (2004) has examined the degree to which falling energy intensities reduced total energy use in the OECD countries between 1973 and 1998.¹² In Figure 6, the lower area shows actual weather-normalised final energy use in the 11 major OECD countries. The upper line represents the hypothetical energy use that would have occurred if energy intensities had remained at the 1973 level in all sectors. By 1998 the savings amounted to 48 EJ, which corresponds to 49% of 1998 energy use level. According to this study, final energy use in these 11 OECD countries would have been 49% higher in 1998 if energy intensities in different sectors and end-uses had remained at their 1973 levels.

These studies show that while energy use is rising in industrialised countries as a whole, it is not rising as much as it would have without end-use energy efficiency improvements. Energy efficiency improvements are reducing growth in energy demand. But growth in population and income, greater demand for energy services, and other factors such as the rebound effects discussed above and technological innovations are in general driving up energy demand to a greater degree than efficiency improvements are constraining demand. The critics are justified in pointing out this basic phenomenon.

There are a few specific examples where the energy savings from high rates of energy efficiency improvement have outstripped the growth in energy demand due to rising population and income. In Denmark, final energy demand declined 26% in households, 19% in manufacturing and 6% in the service sector between 1973 and 1988 (IEA 2004). Substantial improvements in energy efficiency resulted from expansion of cogeneration and district heating systems, tightening of building energy codes, appliance labelling and standards, and grants for retrofit of homes and government buildings (IEA 2002). In addition, the Danish government adopted “green” energy and CO₂ taxes on business and industry during the 1990s, with a large portion of the tax revenue used to subsidise energy efficiency improvements and conservation measures (IEA 2002).

¹² As noted above, energy intensity as used in this IEA report refers to energy use per unit of activity such as floor space heated or vehicle-kilometres driven. It excludes reductions in energy use due to structural changes within and across sectors of a country’s economy.

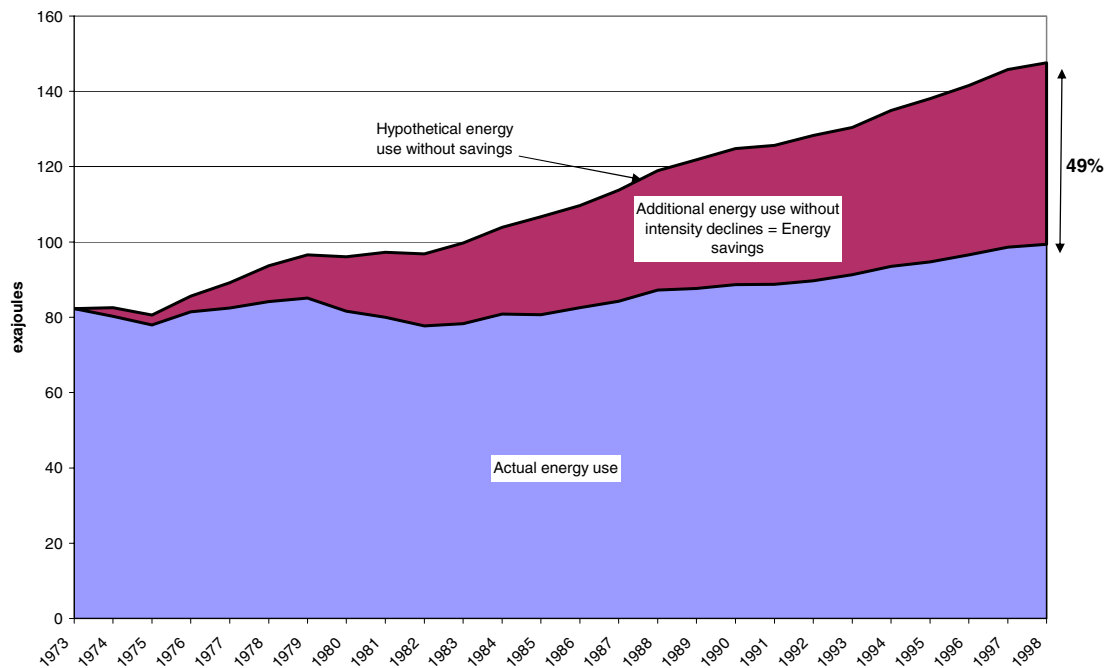


Figure 6. Actual energy use and hypothetical energy use without intensity reductions in 11 OECD countries (IEA 2004)

In another example, the energy consumption of new refrigerators sold in the United States decreased from 1 725 kWh per year in the early 1970s to 490 kWh per year by 2001, due primarily to the adoption of state and then federal energy efficiency standards (Nadel 2002). As a consequence, the total electricity consumption of all refrigerators in use in the U.S. is expected to decline from approximately 113 billion kWh per year in 1984 to 94 billion kWh per year as of 2015 (Geller 1988; EIA 2003). This decrease in absolute energy use is occurring even though the number of households, income and average refrigerator size are all rising, and new features such as automatic icemakers and through-the-door water and ice service are being added to refrigerators.

Energy efficiency policies should be designed so that they do not inadvertently encourage bigger homes, appliances and vehicles, or energy-wasteful behaviour or lifestyles. Efficiency standards, for example, could increase in stringency as the floor area of the home, size of the appliance, or weight of the vehicle increases. Lebot et al. (2005) suggest absolute energy consumption or CO₂ emissions targets on new homes or appliances, with penalties for homes or appliances that exceed the limit. Likewise taxes can be used to discourage energy-inefficient behaviour and lifestyles, as well as inefficient technologies.

Regarding the contention that it is preferable to encourage behavioural and lifestyle changes rather than promote greater energy efficiency, a few comments are warranted. First, the proponents of this viewpoint have not demonstrated that it is feasible to halt growth in energy consumption in the U.S., Europe, or other OECD regions simply by promoting more environmentally-friendly lifestyles and behaviour. Second, it is not clear that encouraging behaviour and lifestyle change would save more energy than promoting more efficient technologies.

Third, and most important, this does not need to be an “either-or” choice. Less materially-oriented behaviour and lifestyles (i.e. lower demand for energy services) can be encouraged along with more

efficient technologies. For example, a sustainable energy scenario for France combines measures to discourage excessive consumption, energy efficiency improvements, and accelerated implementation of renewable energy sources in order to achieve a 63% reduction in per capita CO₂ emissions during 2005-2050 (Salomon et al. 2005). Furthermore, energy efficiency improvements provide more than three times as much energy savings as measures that lower the demand for energy services in this scenario. The contribution that each strategy can make to reducing energy use and greenhouse gas emissions is likely to be culturally dependent, i.e. vary from country to country, and is a topic for further research.

Summary

The allegations that specific energy efficiency improvements increase rather than decrease overall energy use appear to be based on superficial linkages rather than rigorous analysis. Review of the magnitude of the direct (behavioural) and indirect (macroeconomic) rebound effects, as well as numerous energy efficiency studies, leads to the conclusion that energy efficiency improvements by and large do result in energy savings. In other words, energy use is increasing more slowly than it would be if energy efficiency improvements were not occurring. In a few instances, such as in the case of U.S. domestic refrigerators, policy-driven energy efficiency improvements resulted in a reduction in total energy use in spite of growth in number, size and performance.

Critics are correct in pointing out that energy efficiency efforts alone have not been sufficient to halt growth in energy consumption or CO₂ emissions in the OECD countries. In light of the global warming threat and the energy security concerns that exist today, policy makers should consider devoting more attention to influencing lifestyles and behaviour, in particular combating a “bigger is better” mentality among already affluent households. Policy makers should also make sure that energy efficiency policies do not inadvertently encourage larger homes, appliances, or vehicles, or other energy-wasteful behaviour.

Even if more attention is devoted to influencing lifestyles and behaviour, policy makers should not abandon energy efficiency efforts especially when pursuing the challenging goals of climate stabilisation and environmental sustainability. As Lebot et al. (2005) state, “energy efficiency is but part of the solution.” At the same time, energy efficiency proponents should be careful not to oversell their technologies or policies by promising more or faster energy savings than can be realistically achieved.

Conclusion

The critics of energy efficiency policies and programmes raise some valid issues and concerns. The “rebound effect” does reduce the actual energy savings resulting from the implementation of certain types of energy efficiency measures. At times some energy efficiency advocates or programme managers have overstated the energy savings potential and/or cost-effectiveness of energy efficiency policies and programmes. Also, estimating the net outcome from energy efficiency policies and programmes is much more complicated than measuring the output from energy supply facilities.

But the critics overstate their case when claiming that efficiency policies and programmes are inherently flawed or are a failure because of these issues. The erosion of energy savings due to

rebound effects is relatively modest in most cases. Many energy efficiency policies and programmes yield substantial energy savings when properly evaluated, e.g. using field measurements where appropriate, taking into account “free riders”, and accounting for measure and savings persistence.

Experience across different OECD countries demonstrates that appliance and vehicle efficiency standards, funding of home energy retrofits, utility DSM programmes, and other types of energy efficiency initiatives can be very cost-effective even when factors such as rebound effect, free riders, and real world performance are taken into account. Moreover, it is important to consider all benefits as well as costs when judging the overall value of energy efficiency policies and programmes. This means identifying and estimating the magnitude of non-energy benefits to the extent feasible.

Some of the assertions made by the energy efficiency critics do not appear to be valid. In particular, there is not adequate justification for using relatively high “implicit discount rates” when evaluating the cost-effectiveness of government or utility energy efficiency programmes. High implicit discount rates are an indication of market failures and barriers inhibiting adoption of energy efficiency measures, not of well-functioning energy efficiency markets. There is a wide body of literature documenting multiple and substantial market failures and barriers that inhibit energy efficiency improvements in the marketplace. Energy policy makers should attempt to remove or overcome these barriers, as long as the policies and programmes provide benefits that exceed costs.

Likewise, there is no empirical basis for concluding that energy efficiency policies and programmes inherently harm low-income households. In fact these households can disproportionately benefit if policies or programmes are designed in part to achieve this outcome. In addition, it is reasonable to ask all taxpayers or ratepayers to pay for energy efficiency programmes as long as these programmes provide benefits to society that exceed their costs.

Energy efficiency policies and programmes, like any type of public policy or programme, can be poorly designed or poorly implemented. There are examples of policies and programmes that were not successful, such as early home retrofit programmes or tax incentives for energy efficiency measures implemented in the United States. But existence of these poorly designed or poorly implemented efforts does not mean that all energy efficiency policies and programmes are a failure. The point is to learn from and not repeat past failures.

Considering the breadth of energy efficiency policy and programme experience over the past 30 years, considerable progress has occurred. Energy efficiency researchers and practitioners have greatly improved home retrofit techniques and retrofit programme effectiveness in the United States and other OECD countries, for example. Likewise the design and evaluation of utility DSM programmes also has significantly improved over the years, and is continuing to be refined.

So what should energy policy makers, programme managers and analysts take away from the criticisms that have been levelled at energy efficiency efforts over the years? Our literature review suggests employing the following principles and actions:

- ❖ Take into account the direct and economy-wide rebound effects when estimating the energy savings resulting from energy efficiency improvements.

- ❖ Take into account the long-term trend towards lower energy intensity as well as consumer responses to changing energy prices when evaluating the effectiveness of energy efficiency initiatives.
- ❖ Maximise the number of households and businesses that participate in energy efficiency policies and programmes, and ensure that low-income households are well-served and benefit.
- ❖ Continue to analyse the cost-effectiveness of energy efficiency policies and programmes using discount rates that are used to analyse other government or utility investment options, typically real discount rates in the range of 4 to 8%.
- ❖ Thoroughly evaluate energy savings using techniques such as direct measurements, estimation of “free riders”, and utility billing data analysis.
- ❖ Analyse the full costs and benefits of energy efficiency policies and programmes, including the transaction costs and non-energy benefits.
- ❖ If necessary, modify policies and programmes over time in order to achieve more favourable outcomes.
- ❖ Design policies and programmes in ways that do not inadvertently encourage bigger homes, appliances and vehicles, or energy-wasteful behaviour.
- ❖ Promote both more efficient energy use and behaviour/lifestyle change when pursuing the goals of climate stabilisation and long-term environmental sustainability.

The world is now facing a number of major energy challenges. Carbon dioxide emissions are building up rapidly in the atmosphere while evidence of global warming mounts. If not constrained, global warming during the 21st century and beyond could have devastating effects. At the same time, many experts are predicting that conventional oil production will peak worldwide in the near future. In addition, energy security is of growing concern as the world’s remaining oil reserves become ever more concentrated in the Persian Gulf region.

Increasing the efficiency of energy use is one of the main “tools” that countries can use to address these multiple challenges. Fortunately, policy makers and energy efficiency programme managers have a great deal of experience to draw upon as they design and implement new energy efficiency policies and programmes. At the same time, policy makers and programmes managers should pay attention to and learn from the critics when they design and implement future energy efficiency efforts.

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