17 Beyond Carbon Markets and Technology

Key Messages

Policies to price greenhouse gases, and support technology development, are fundamental to tackling climate change. However, **even if these measures are taken, barriers and market imperfections may still inhibit action, particularly on energy efficiency.**

These barriers and failures include hidden and **transaction costs** such as the cost of the time needed to plan new investments; **lack of information** about available options; capital constraints; misaligned incentives; as well as **behavioural and organisational factors** affecting economic rationality in decision-making.

These market imperfections result in **significant obstacles to the uptake** of cost-effective mitigation, and weakened drivers for innovation, particularly in markets for **energy efficiency** measures.

Policy responses which can help to overcome these barriers in markets affecting demand for energy include:

- **Regulation**: Regulation has an important role, for example in product and building markets by: communicating policy intentions to global audiences; reducing uncertainty, complexity and transaction costs; inducing technological innovation; and avoiding technology lock-in, for example where the credibility of carbon markets is still being established.

- **Information**: Policies to promote: performance labels, certificates and endorsements; more informative energy bills; wider adoption of energy use displays and meters; the dissemination of best practice; or wider carbon disclosure help consumers and firms make sounder decisions and stimulate more competitive markets for more energy efficient goods and services.

- **Financing**: Private investment is key to raising energy efficiency. Generally, policy should seek to tax negative externalities rather than subsidise preferable outcomes, and address the source of market failures and barriers. Investment in public sector energy conservation can reduce emissions, improve public services, fostering innovation and change across the supply chain and set an example to wider society.

Careful **appraisal, design, implementation and management** helps minimise the cost and increase the effectiveness of regulatory, information and financing measures. Energy contracting can reduce the costs of raising efficiency through economies of scale and specialisation.

Fostering a shared understanding of the nature and consequences of climate change and its solutions is critical both in shaping behaviour and preferences, particularly in relation to their housing, transport and food consumption decisions, and in underpinning national and international political action and commitment.

Governments cannot force this understanding, but can be a catalyst for dialogue through evidence, education, persuasion and discussion. And governments, businesses and individuals can all help to promote action through **demonstrating leadership**.

17.1 Introduction

Chapters 14, 15 and 16 have outlined the arguments, and appropriate policies, for establishing well-functioning carbon markets and encouraging technological research, development and diffusion. These are necessary to provide incentives and enable mitigation responses by households and firms. However, alone, they are not sufficient to elicit the necessary scale of investment and behavioural responses from households and firms due to the presence of failures and barriers in many relevant markets.

These obstacles are outlined in Section 17.2, in particular in relation to actions and investments for energy saving (although the framework is broadly applicable to other aspects of mitigation such as fuel switching). The significant untapped energy efficiency potential which exists, for example, in the buildings, transport, industry, agriculture and power sectors provides evidence of the impact of these failures and barriers.

Sections 17.3 to 17.5 outline the role of regulation, information and financing policies in responding to obstacles to energy efficiency:

- *Regulation:* such as forward-looking standards stimulate innovation by reducing uncertainty for innovators; encourage investment by increasing the costs and commercial risks of inaction for firms; and reduce technology costs by facilitating scale economies. In some respects regulation involves the creation of an implicit carbon price;
- *Information:* encourages efficient consumption and production decisions by raising awareness of the full energy costs and climate impacts; evidence and guidance on how to assess options and reduce energy bills can explicitly shape the direction and priorities for innovation;
- *Financing:* can accelerate the uptake of energy efficiency in both private and public sector.

Section 17.6 outlines issues relating to policy delivery. Section 17.7 discusses the role of public policy, information, education and discussion in influencing the perceptions and attitudes of individuals, firms and communities towards both adopting environmentally responsible behaviour and co-operating to reduce the impacts of climate change.

17.2 Market Failures and Responses to Incentives

Behaviour is driven by a number of factors, not just financial costs and benefits.

For the most part, investment decisions in energy-using technologies rest on the balance of financial costs and benefits facing an individual or firm: for example, how much additional investment is required, what is the (opportunity) cost of capital and, in comparison, how much energy is the investment expected to save?

However, consumers and firms frequently do not make energy efficiency investments that appear cost-effective.[1] The IEA estimate that unexploited energy efficiency potential offers the single largest opportunity for emissions reductions, with major potential across all major end uses and in all economies. For example, energy efficiency accounts for between 31% and 53% of CO2 emissions reductions by 2050 under the accelerated technology scenario (see Chapter 9 for a discussion of sources and costs of mitigation).[2]

It is difficult to explain low take up of energy efficiency as purely a rational response to investment under uncertainty.[3] This implies the existence of one or more of a potentially wider set of costs, market failures, or 'barriers'[4] to 'rational' behaviour and motivation. These fall into three main groups:[5]

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[1] Individuals and firms should invest until the expected savings are equal to the opportunity cost of borrowing or saving (assuming risk neutrality). Studies suggest that individuals and firms appear to place a low value on future energy savings. Their decisions expressed in terms of standard methods of appraisal would imply average discount rates of the order of 30% or more. See, for example, analysis of consumer behaviour in markets for room air conditioners and home insulation in the US during the 1970's and 1980's by Hausman (1979) and Hartman and Doane (1986)). Also see Train (1985).

[2] IEA (2006)

[3] For example, Metcalf (1994) applies portfolio theory to show that investors should observe *lower* discount rates relative to the opportunity cost of capital, because reduced exposure to energy costs hedges against other risks. Dixit and Pindyck (1994) use 'option value' theory to explain relatively *higher* discount rates however Sanstad et al. (1995) show empirically, that these are not sufficient to explain the low take up of energy efficiency investment.

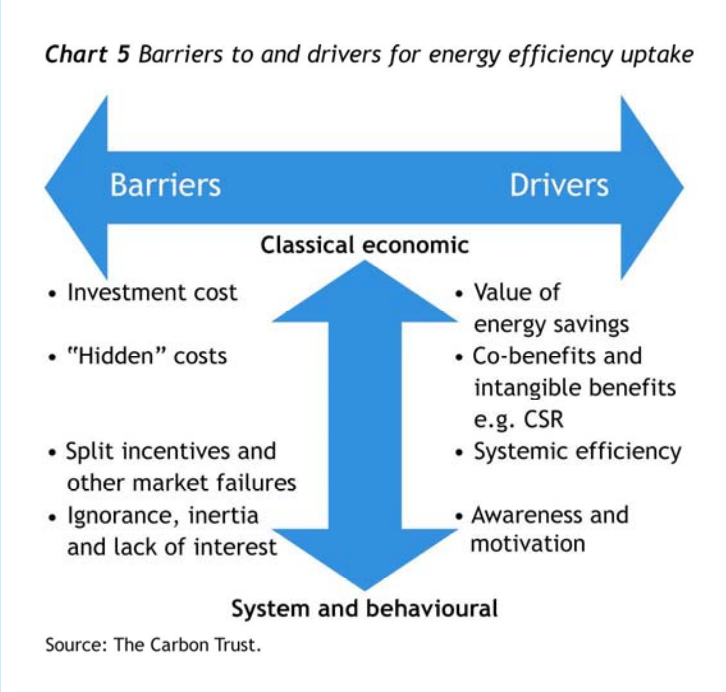
[4] See for example Blumstein et al. (1980), Grubb (1990). Also, see Mills (2002) for analysis of impacts of barriers on energy demand for lighting.

[5] Adapted from the Carbon Trust, *The UK Climate Change Programme: Potential Evolution for Business and the Public Sector*. London: The Carbon Trust. This framework was originally designed to evaluate markets for energy conservation in the business and public sector. However, it can be applied more broadly to other sectors and to other areas of mitigation such as fuel switching.

- Financial and 'hidden' costs and benefits;
- Multiple objectives, conflicting signals, or, information and other market failures;
- Behavioural and motivational factors.

These are illustrated in the Figure 17.1 below. Standard economic theory of rational decision-making under uncertainty is important in understanding each. However, moving down this list, systems and behavioural theories of decision-making are progressively more relevant.

Figure 17.1 Barriers to and drivers for energy efficiency uptake[6]



Note: CSR is Corporate Social Responsibility

An assessment of the case for action has to take into account the existence of "hidden" costs and benefits

The primary driver of much investment in energy-using technologies is the balance of financial costs and benefits facing an individual or firm. However, accounting for "hidden" costs, such as those associated with researching different options, taking time off work to wait in for tradesmen, or the opportunity cost of devoting managerial time to efficiency projects is required for an assessment of the full range of costs and benefits.[7] These hidden costs may be counter-balanced by wider benefits such as reduced risk exposure to energy price volatility, or reputational benefits from demonstrating environmental responsibility.

Hidden or transaction costs are difficult to measure. One study found search and information costs of energy efficiency measures of between 3% and 8% of total investment costs.[8] Box 17.1 below summarises research highlighting the likelihood of significant transaction costs associated with energy efficiency measures. In general, these wider costs are expected to have most significant impact among small and medium-level energy users such as households, non-energy intensive and particularly small firms, as well as the public sector.

[6] Framework designed in relation to energy efficiency markets but applicable more generally to mitigation (including fuel switching).
[7] Much of this argument relates to issues of transaction costs, see for example Williamson (1981, 1985).
[8] Hein and Blok (1994)

Box 17.1 Estimating the Costs of Energy Savings

Joskow and Marron (1992) undertook a study of the costs of information and particularly investment programs undertaken by energy suppliers designed to reduce demand among residential, commercial and industrial customers in the US. The authors identified a tendency for studies to underestimate the costs of actions to save energy,[9] in particular:

- *Supplier transaction costs*: full accounting for all administrative costs was likely to increase the cost per kWh saved by 10% to 20%. Supplier administration costs were likely to exceed 30% of the total for commercial and industrial programs;
- *Customer transaction costs and 'free riding'*: customer transaction costs varied from close to zero to close to 100% of the direct investment costs across the programmes sampled. 'Free riding'[10] was considered a significant risk particularly among the heaviest energy users within any target group. It was estimated that full accounting of these factors was likely to increase costs of demand side management programmes by about 25% to 50%;
- *Energy saving measurement issues*: The study identified significant methodological issues estimating energy savings given diverse, dynamic patterns of customer demand and limited availability of baseline information. In addition, they identified a tendency for widely used ex post engineering based forecasts to significantly overstate economic savings. Overall, accurate measurement of energy savings was considered likely to increase estimated costs by about 50%.

Individuals and firms are not always aware of the full costs and benefits of energy conservation, are capital constrained, or do not have sufficient incentives to invest.

Reliable, accessible and easily understandable information is important in making consumers and firms aware of the full lifetime costs and benefits of an economic decision, and hence supporting good decision-making. Whilst there are information difficulties in many or most markets, they may be particularly powerful in relation to energy efficiency measures.

Capital and/ or asset market failures also inhibit action. For example, a lack of available capital prevents people investing in more energy efficient processes which typically have higher upfront costs (but are cheaper overall when evaluated over a longer period). Restricted access to capital is especially common among poor households and small firms, particularly in developing countries.

Incentive failures restrict the effectiveness of price instruments. An example in the buildings sector is the 'landlord-tenant' problem in which landlords do not invest in the energy efficiency of their asset, because tenants benefit from lower energy bills, and more efficient capital typically does not command sufficiently higher rents.

Individuals and firms are not always able to make effective decisions involving complex and uncertain outcomes. Social and institutional norms and expectations strongly influence decision-making, although these norms are not immutable.

Some economists have suggested that people use simple decision rules when faced with complexity, uncertainty or risk.[11] For example, many people are unable to calculate the long-run value of energy savings, or have difficulties determining appropriate responses to risks and uncertainties around future energy costs or the potential impacts of climate change. As a result, individuals and firms commonly make decisions which simply meet their needs, rather

[9] Study compared costs against results of research by the Electric Power Research Institute and Rocky Mountain Institute (Lovins)
[10] An individuals or firm that takes advantage of financial support for a particular energy efficiency measure who would have invested without the additional incentive is a free rider in this context. This differs from the use of the term in the context of international agreements on climate change where non-signatories enjoy the benefits of mitigation but do not incur the costs, see Chapter 21.
[11] Kahneman & Tversky (1979, 1986, 1992) developed the idea of 'prospect theory' in which people determine the value of an outcome based on a reference point.

than undertaking complex analysis to determine the best possible decision.[12]

Shared social and institutional norms are important determinants of behaviour.[13] Individuals and firms behave habitually and in response to social customs and expectations. This leads to 'path dependency", which limits their responses to policies designed to raise efficiency (or encourage fuel switching). However, these norms change over time in response to a whole range of factors, including the influence of the media and action by governments. Developing and encouraging a shared concept of what responsible behaviour is, and of the consequences of irresponsible actions, is therefore an important aspect of policy (see Section 17.7).

17.3 Policy responses: Regulation and Standards, Direct Controls

Regulatory measures are less efficient and flexible than market mechanisms in the context of perfect markets, but can be an efficient response to the challenge of irremovable or unavoidable imperfections.

This section discusses the economic rationale for different types of regulatory policy instruments. As Chapter 14 discussed, regulatory measures are generally less efficient than market mechanisms when applied to perfect markets. However, the existence of market failures and barriers outlined in the previous section mean that there are circumstances in which standards and regulations have an important role to play.

Regulatory measures may be appropriate either instead of, or complementary to, tax or trading instruments, and can be more effective and efficient in a number of important circumstances, in particular to:

- Reduce the complexity faced by consumers or firms, by restricting or removing the availability of inefficient (or polluting) technologies, for example through banning of Chloroflourocarbons (or CFC's) in cooling systems;

- Cut the transaction costs associated with investments, through measures, for example by simplifying planning rules relating to the installation of micro-generation technologies;

- Overcome barriers to the transmission of incentives throughout the supply chain, for example, agreements with cable and satellite television providers have resulted in significant improvements in the efficiency of licensed 'set top' boxes;

- Stimulate competition and innovation, by signaling policy intentions, reducing uncertainty and increasing scale in markets for outputs of technological innovation;

- Promote efficiency through strategic coordination of key markets, for example by reducing long-run transport demand through integrated land-use planning and infrastructure development;

- Overcome practical constraints on policymakers to imposing the appropriate explicit carbon price,[14] for example where this may be politically difficult to achieve or administratively expensive to implement directly through markets;

- Avoid capital stock 'lock in', particularly in markets which are subject to lengthy capital replacement cycles, for example buildings and power sectors.[15] This may be important where the credibility of carbon markets is still being established (issues discussed in Chapter 15).

[12] See Simon, H.A. (1959) for concept of 'satisficing'. See also transcript of 2005 Bowman Lecture: Energy Demand - Rethinking from Basics, Professor David Fisk submitted to Stern Review Call for Evidence http://www.hm-treasury.gov.uk/media/F7E/46/climatechange-fisk_1.pdf

[13] This is commonly known as 'evolutionary' or 'procedural' rationality. See, for example, Goldstein, D. (2002), Decanio (1998)

[14] Equal to the expected marginal environmental cost.

[15] Note that, in some circumstances, poorly designed and managed regulation can cause technology lock in.

Regulatory approaches, in contrast with market mechanisms, place a value on reducing greenhouse gas emissions implicitly rather than explicitly and can help reduce obstacles associated with information or other market failures. This value can be calculated by dividing the cost of the measure (to firms, consumers and regulators) by the estimated savings in greenhouse gas emissions. From the point of view of maximizing efficiency losses, it is important that the implied value of carbon, at the margin, is broadly the same whether market mechanisms or regulatory measures are used.

Performance standards help to limit energy demand by removing inefficient products from the market, and promoting mass diffusion of more efficient alternatives.

Performance standards establish requirements to achieve particular levels of energy efficiency or carbon intensity without prescribing how they are delivered. This can take the form of a minimum standard for a particular type of good, or a requirement on their average performance (commonly known as a 'fleet averages').[16]

Standards encourage the removal of poorly performing equipment from the market completely, or improve availability and uptake of more efficient alternatives. In addition, by projecting the future levels of performance which will be required, standards have the potential to encourage innovation towards the production of more efficient products: for example, US federal energy efficiency standards on room air conditioner and gas water heaters are estimated to have elicited energy efficiency improvements of approximately 2% per annum.[17]

The overall costs of regulation depend on the precise policy context. It is likely that performance standards induce the creation and adoption of new technologies although at some real opportunity cost.[18] Nevertheless, there are opportunities to promote efficiency at very low, or even negative cost, for example in certain product markets. Box 17.2 shows examples of effective performance based regulations. Section 17.6 outlines issues relating to design and implementation of performance standards.

Box 17.2 Successful Performance Standards Programmes

Buildings: Building codes have been applied in many different countries.[19] In California, they are estimated to have saved approximately 10,000 GWh of electricity roughly equal to 4% of annual electricity use in 2003.[20] Studies of codes applied in Massachusetts and Colorado in have also demonstrated their potential to deliver energy saving.[21] In the UK, building regulations are expected to yield a cumulative saving of 1.4 MtC02 per year in 2010.[22] The EU Commission established a framework to realize an estimated cost-effective savings potential of around 22% of present consumption in buildings across the EU by 2010 as part of the European Energy Performance of Buildings Directive. In China, regulations are estimated

[16] Fleet averages, such as Corporate Average Fuel Economy vehicle standards, place average performance requirements on a particular type of good, thereby not mandating the removal of the poorest quality but rather incentivising patterns in the overall distribution of the efficiencies of products sold.
[17] Newell et al. (1999) using a model of induced product characteristics. Greening et al (1997) estimated the impacts of 1990 and 1993 national efficiency standards on the refrigerators and freezer units, using hedonic price functions, and found that the quality-adjusted price fell after implementation of standards. See also Magat (1979). However, in other instances, studies found no clear evidence of performance standards impacting on technological innovation. See For example, see Bellas (1998), Jaffe and Stavins (1995).
[18] See, for example, Palmer et al. (1995)
[19] An OECD study: *Environmentally Sustainable Buildings - Challenges and Policies f*ound that 19 out of 20 countries surveyed had legislated mandatory building: http://www1.oecd.org/publications/e-book/9703011E.PDF#search=%22OECD%20study%3A%20Environmentally%20Sustainable%20Buildings%20-%20Challenges%20and%20Policies%20%22
[20] California Energy Commission (2005): http://www.energy.ca.gov/2005publications/CEC-400-2005-043/CEC-400-2005-043.PDF
[21] Evaluation of New Home Energy Efficiency: An assessment of the 1996 Fort Collins residential energy code and benchmark study of design, construction and performance for homes built between 1994 and 1999. Summary report June 2002 : http://www.estar.com/publications/Evaluation_of_New_Home_Energy_Efficiency.pdf
XENERGY, 2001: Impact analysis of the Massachusetts 1998 residential energy
Code revisions: http://www.energycodes.gov/implement/pdfs/Massachusetts_rpt.pdf
[22] Regulatory Impact Assessment, 2006 amendment to part L building regulation http://communities.gov.uk/pub/308/RegulatoryImpactAssessmentPartLandApprovedDocumentF2006_id1164308.pdf

to apply to buildings with a floor space of approximately 500 million square meters (among a total of approximately 40 billion nationwide) and have saved 36 MtCO2.[23]

Appliances: Since the introduction of federal standards by the US Department of Energy in 1978, total government programme expenditure is equivalent to US$2 per household. This is estimated to have delivered US$1,270 per household of net-present-value savings to the U.S. economy during the lifetimes of the products affected. Projected annual residential carbon reductions in 2020 due to these appliance standards are approximately 37 MtC02, an amount roughly equal to 9% of projected US residential carbon emissions in 2020.[24]

China first introduced appliance standards in 1989 and expanded their application rapidly during the 1990's to include, for example: refrigerators, fluorescent ballasts and lamps, and room air-conditioners. By 2010, energy savings are estimated to reach 33.5 TWh, or about 9% of China's residential electricity. This is equivalent to a CO_2 emission reduction of 11.3MtC02.[25] A more recent study highlighted the potential for significant energy savings in the longer term from more stringent performance standards on three major residential end uses: household refrigeration, air-conditioning, and water heating.[26]

Transport: Japan's Top Runner scheme, a leading programme of fleet averages in which future average performance requirements are based on current best available technologies, applies to a range of energy using products.[27] It is estimated to have delivered energy savings on diesel passenger vehicles of 15% between 1995 and 2005 (and 7% on diesel freight vehicles). By 2010, it is expected to deliver energy savings on gasoline passenger vehicles of 23% (and 13% on passenger freight vehicles).[28]

In response to the introduction of Corporate Average Fuel Economy (CAFE) standards in the USA in 1975, the average fuel economy of new cars almost doubled and that of light trucks increased by 55% from 1975 to 1988.[29] Without these efficiency improvements it is estimated that the US car and light truck fleet would have consumed an additional 2.8 million barrels of gasoline per day in the year 2000 (about 14% of 2002 consumption levels).[30] However, the average rated fuel economy of new cars and light trucks combined declined from a high of 25.9 miles per gallon in 1987 to 23.9 miles per gallon in 2002, partly because of the shift from cars towards less efficient sport utility vehicles, pick-up trucks and minivans (which were classified as cargo transport under CAFE standards).

Design standards are inflexible, but can create scale economies for strategically important technologies.

Design standards mandate, or prohibit, the use of a particular technology. For example, CFC gases were prohibited in refrigerators in favour of alternative coolants, following the Montreal Protocol in 1987 and the establishment of a strong causal link with ozone depletion. Design standards and prohibitions are inflexible measures and, as such, risk being inefficient relative to performance standards or market mechanisms.

However, their application may be appropriate where a particular technological solution is highly preferable (or undesirable in the case of prohibitions) in the short term, where it is considered imperative to accelerate 'pull through' and create scale economies for a particular technology in the medium or longer term, or where alternative measures have proved unsuccessful. The need for medium term 'pull' through, for example, is likely to apply in the context of certain carbon capture and storage technologies since coal is a particularly

[23] New Era of China Building Energy Saving, Speech by Mr. Zhang Qingfeng, Chairman of China Council of Construction Technology, April 10th
[24] Meyers (2002). Savings evaluated by comparing against base case estimated without policy intervention
[25] China Markets Group, Lawrence Berkeley Laboratories: http://china.lbl.gov/china_buildings-asl-standards.html
[26] Lin (2006)
[27] 'Top Runner' fleet average requirements are agreed on a voluntary basis between the Japanese government and industry. They apply to approximately 18 different groups of energy using technologies in a range of markets including appliances, heaters and vehicles.
[28] Top Runner Programme: Developing the World's Best Energy Efficient Appliance, Energy Conservation Centre Japan (2005): http://www.eccj.or.jp/top_runner/index.html
[29] Geller & Nadel (1994)
[30] National Academy of Sciences (2002) http://newton.nap.edu/books/0309076013/html/111.html

damaging source of GHG's while it is likely to be widely used in power markets in a number of countries on grounds of cost and energy security (see Chapters 16 and 24 for details).

Urban design and land use planning regulations have the potential to facilitate a less energy intensive society, while balancing a range of wider economic and social objectives.

Planning rules and regulations balance a complex range of economic, social, and environmental objectives. However, their design and implementation can have important implications for mitigating climate change and also has the potential to influence the resilience to the impacts of climate change, for example, in the management of flood risks or water scarcity (these issues are examined in Part 5 of the report).

Achieving planning permission is often an important transaction cost when installing renewable energy technologies, such as wind turbines or solar panels, or energy conservation measures such as solar water heaters. This applies to both large-scale commercial as well as microgeneration installations (see Box 17.3 below).

Box 17.3 Microgeneration Technologies

Microgeneration technologies produce thermal and/or electrical energy. Examples include small-scale wind, solar, hydro or combined heat and power installations, as well as heat pumps and solar water heaters. According to the Energy Saving Trust, micro-generation could supply 30-40% of UK electricity demand by 2050.[31]

Deployment of microgeneration capacity has the potential to reduce the carbon intensity of industrial, commercial, public as well as residential buildings and developments. In addition, it can reduce energy wastage compared to centralised systems.[32] Greater uptake could be driven by: consumers, energy suppliers and firms selling energy services, and the implementation of private wire networks by planners and developers (see Box 17.9 on Woking).

However, many of the technologies are currently expensive relative to the delivered price of conventional energy sources. Enabling investors to sell excess electricity at the real-time market price, and subject to distribution or other charges reflecting limited demand on low voltage networks, is key to their cost effectiveness: the use of smart meters in microgeneration installations is an important enabler.[33] Appropriate regulatory frameworks for energy markets and distribution networks are also important to achieving a level playing field.

Incentives to consumers and energy suppliers could accelerate the reduction of technology costs and promote diffusion. Finally, relaxation of planning rules also has the potential to reduce transaction costs and promote network effects through heightened awareness of these technologies.

Spacial and strategic planning can affect patterns of energy consumption. Higher-density urban environments, for example, typically consume less energy for transport and in buildings. In addition, land use controls such as restrictions on the availability and pricing of parking spaces, the use of pedestrian zones and parks, and land use zonal strategies (including congestion charging), have the potential to support integrated public transport to reduce the use of private motor vehicles.

[31] Energy Savings Trust, Potential for Microgeneration Study and Analysis (2005) http://www.dti.gov.uk/files/file27558.pdf

32 For example, an estimated 20% of the UK's CO2 emissions result from energy wasted in the combustion, transmission and distribution of energy from centralised fossil fuel power plants. Greenpeace, Decentralising power: an energy revolution for the 21st century generation, transmission and distribution http://www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/7154.pdf#search=%22greenpeace%20%2B%20microgeneration%22

[33] Unlocking the power house: policy and system change for domestic micro-generation in the UK. http://www.sussex.ac.uk/spru/documents/unlocking_the_power_house_report.pdf

Higher energy prices and rising congestion require central and municipal planners to develop mass transit systems to cope with inner city and suburban traffic such as: bus rapid transit, urban trams and relatively cheap light railway systems, in addition to subways for larger, higher density metropolitan centres. Such systems lead to large gains in energy efficiency and reduced emissions as passengers transfer from private cars to public transport.

The development of Dongtan in China provides an important example of the potential for sustainable urban development across the rapidly urbanising transition and developing economies of the world (see Box 17.4).

Box 17.4 Dongtan, Eco-City, Shanghai

Dongtan is situated on Chongming Island off the coast of Shanghai. This rural area is undergoing a rapid economic transformation into an 'eco city', facilitated by the construction of the Shanghai Yangtze River Tunnel bridge, which began in 2004, linking this region directly to the Shanghai conurbation.

Project engineers at Arup are working with Shanghai Industrial Investment Company to develop and construct Dongtan, an 86-square kilometer project, into a prosperous city which achieves a stable balance between economy, society and the environment. The city is being developed in phases but is expected to have a population of 25,000 by 2010 and around 80,000 after 2020, growing to a total of several hundred thousands in the longer term.

Dongtan will have highly energy efficient buildings powered by renewable energy sources including wind, solar and biofuels. Its energy intensity will be reduced through the use of passive energy systems: for example by making full use of natural sunlight to light public and private spaces or by varying the heights of buildings to reduce heating and cooling arising from adverse weather conditions. In addition, its waste will be recycled and composted.

Chinese policy makers and planners have been impressive in scaling up best practice to help achieve their objective to reduce the ratio of energy demand to output by 20% over 5 years. In the case of Dongtan, a high-speed rail link to Shanghai is planned, while the city itself is being designed in a compact, inter-linked way, supported by mixed patterns of land use, and a network of pedestrian and cycle routes, in order to reduce the demand for private motorised transport (and associated infrastructure costs).[34]

17.4 Policy Responses: Information policy

Information policies can achieve a number of objectives.

Well-designed information policies can:

- Provide people with a fuller picture of the economic and environmental consequences of their actions;
- Stimulate and provide the framework for market innovation and competition in environmentally friendly goods and services, for example through performance indicators and labels;
- Reduce the transaction costs associated with investments, by providing information on the energy use characteristics of different products or processes;
- Prompt people to take responsible action, by informing them about the wider implications of their choices and by highlighting public policy priorities.

Information policies take a number of forms. This section discusses a few generic types and their potential market applications including: labelling and certification, billing and metering, and policies to disseminate best practice.

[34] Further information is available in the publication: Shanghai Dongtan: An Eco City, published by SIIC Dongtan Investment & Development (Holdings) Co., Ltd. Arup

Labels, certificates and endorsements raise the visibility of energy costs in investment decisions, promote innovation in product markets, and support procurement initiatives.

The energy use, costs and environmental consequences of purchasing decisions commonly have low visibility, particularly when compared to the purchase price of a good.[35] Where such labels do exist, they can have a significant impact on consumer behaviour: organic certification and the FAIRTRADE mark are two examples (see Section 17.7 discussion of preferences for environmentally and socially responsible production and consumption).

In the field of energy efficiency, labels, certificates and endorsements support more rational purchasing decisions, by allowing people to make comparisons between competing goods on the basis of their operating cost and environmental impact. They also make it cheaper and easier for firms or the public sector to implement sustainable procurement policies.

Box 17.5 highlights a number of successful schemes. These vary in design, and include labels giving comparative information on energy use, and endorsements which state that a product meets a particular standard.

There are considerable opportunities for broader or more stringent application of performance and endorsement labels in key product areas such as: domestic lighting, consumer electronics, white goods, electric motors, boilers, air conditioning units, and office equipment.[36] Biogas is an example of an agricultural product that could have value as a renewable substitute for fossil fuels; establishing product standards supported by labelling can allow consumer demand to help to create this market.

The cost and regulatory burden of such measures should be taken into account when designing them; Section 17.6 outlines key principles for effective design and management. Such measures may be much more powerful if they are applied at an international level. The issues involved in this are discussed in Chapter 24.

[35] Hassett and Metcalf (1995), for example, showed that consumers were much more responsive to changes in installation cost than change in energy prices. This is also inferred by the findings of Jaffe and Stavins (1995) which showed that consumers were about three times as sensitive to changes in technology costs than changes in energy prices.

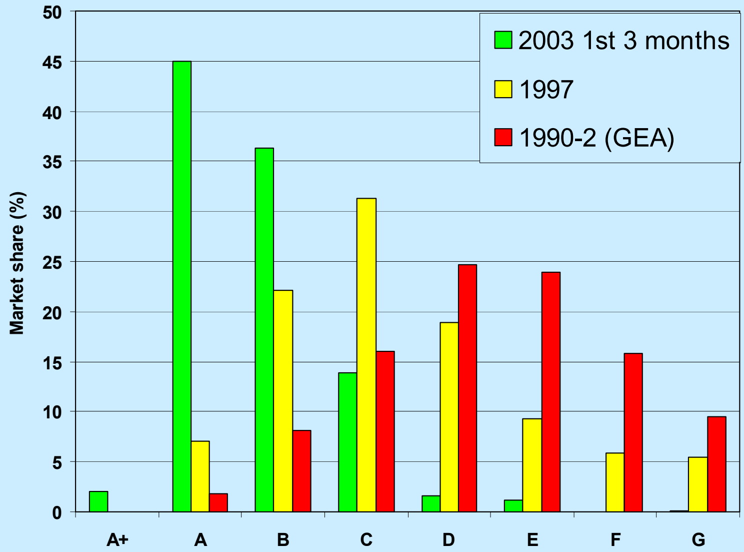
[36] See for example IEA (2003), Lin (2006)

Box 17.5 Successful Labels, Certificates and Endorsements in the US and EU

USA: The US *Energy Star* one of the best-known information and endorsement programmes, applying to over 30 products. It is estimated to have delivered annual savings of US$4.9 billion savings in 2002 (an increase of almost 30% over 2001). This is targeted to rise to US$55 billion in 2010 and US$140 billion in 2020.[37]

EU: The introduction of an EU labelling scheme on refrigerators is estimated to have delivered one-third of the 29% improvement in the energy efficiency of refrigeration products between 1992 and late 1999.[38] The figure below shows a clear and strong evolution of the market toward higher-efficiency products since the introduction of the EU label (contrasting favourably with the predominantly flat efficiency trends immediately prior to its announcement).

Impact of the EU refrigerator energy label: sales of refrigerators in the EU by energy label class, 1992-2003.



Regular and accurate energy billing, as well as displays and smart meters have the potential to promote conservation among energy users and reduce the operating costs of utilities.

Giving individuals and firms accurate and timely information on their energy use can act as a spur to investment in energy efficiency and the adoption of energy saving behaviours. New technologies are now available which have the potential to make this a much more powerful tool.

- **Energy bills** are most effective when they are regular, accurate, and informative. Bills which reveal historical patterns of energy consumption, and/or details on how consumption levels compare with a similar household or firm, are potentially effective in encouraging a response;[39] However, many people receive irregular bills, which are often based on estimated levels of consumption.[40] This problem is most prevalent

[37] Webber et al. (2004). Figures discounted at 4%. Potential savings of US$160 in 2010 and $US390 in 2020 are projected if 100% of products within particular classes are energy star compliant.
[38] Bertoldi (2000)
[39] Darby S. (2000) Wilhite, Hoivik and Olsen (1999) Eide and Kempton (2000) A recent survey for Ofgem suggested that consumers in the UK preferred bar charts highlighting consumption levels compared to relevant historical periods. http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/8401_consumer_fdbak_pref.pdf
[40] For example, the UK Energy Review (2006) estimated that between 25 and 50% of all energy bills from UK energy suppliers were based on estimates.

among those consuming small and moderate quantities of energy such as households, small firms and those in non-energy intensive, service, or public sectors;

- **Real time electricity displays** inform consumers on energy consumption levels (and associated costs) directly and in real time. Estimated to cost in the region of £2-6 annually over 5 years,[41] they have been successful in encouraging energy conservation behaviours among households resulting in average reductions of 6.5% (net of technology costs).[42] Further development of a comparable display technology for metered gas supplies might extend these opportunities;

- **Smart meters** provide customers with sophisticated energy price and cost information. Those with "time of use" functionality enable flexible energy pricing. This allows suppliers to impose a higher price for peak-time energy, resulting in load shifting and consequently reducing base load capacity needs. Trials in California, for example, indicated reductions in peak period energy use by residential customers of between 8% and 17%;[43]

  Smart meters with an 'export facility' encourage the diffusion of micro-generation capacity by enabling people to be paid at a different rate for the supply of their electricity into the local distribution network - which is critical to the cost effectiveness of these technologies in the medium term. Purchase and installation of smart meters are estimated to cost between £40 and £180 depending on function.[44] In addition to savings enjoyed by customers able to reduce peak level demand, Californian utilities recovered over 90% of the initial technology cost through savings made in metering, billing and systems.[45]

Sharing best practice encourages and enables individuals and firms to increase energy efficiency.

The energy efficiency of individuals and firms often varies widely within the same market. In transport, for example, particular styles of driving are more efficient than others. An in-car technology known as gear shift indicators which informs motorists when they should change gear in order to maximise fuel efficiency for any given engine speed could improve fuel economy by up to 5%.[46] In addition, methodologies for identifying best practice, for example through benchmarking, also have the potential to support wider policies on mitigation (see Box 17.3).

In the buildings sector, for example, large numbers of poor quality and inefficient buildings are constructed despite the existence of a range of cost effective technologies and design techniques. Training architects, designers and construction technicians on the principles and application of 'sustainable' design and efficient technologies, and on relevant policy frameworks develops market capacity to supply efficient buildings. However, coordinating different elements of the construction industries is a key barrier. [47]

The long term cost effective energy efficiency potential of a building is heavily determined by decisions made at the design phase (although there are widespread opportunities to retro fit technologies especially given the lengthy capital replacement cycle of buildings and often low performance of existing stock). As such, polices which target this window of opportunity may have significant potential to reduce emissions from buildings, especially in fast growing construction markets.

In the UK, the Carbon Trust, an independent but largely publicly funded company provides a range of advisory services to business of all sizes as well as the public sector. In 2005/06, the

[41] DTI Energy Review Report (2006) http://www.dti.gov.uk/files/file31890.pdf
[42] A summary of the various studies can be found in: Darby S. (2006)
[43] California Energy Commission (2005) IEA (2006) identifies potential energy savings of 5-15% from 'smart' meters.
[44] DTI Energy Review Report (2006)
[45] California Energy Commission (2005)
[46] Presentation by Toyota as Stern Review Transport Seminar 12 January 2006 http://www.hm-treasury.gov.uk/media/B70/64/stern_transportseminar_toyota.pdf
[47] Lovins (1992), Golove and Eto (1996)

organisation helped its customers save between 1.1 and 1.6 MtC02 and identify potential savings of 3.9 MtC02 annually at an average lifetime programme administration cost of £5-7/tC02.[48]

Box 17.6 Benchmarking: driving conservation and facilitating mitigation policy

Benchmarking enables sharing of best practice and helps identify and encourage energy conservation opportunities. For example, the G8 communiqué from Gleneagles 2005 called on the IEA to benchmark the most efficient coal fired power stations and to identify ways of sharing best practice globally.[49] As previously outlined, benchmarking consumption patterns on energy bills has the potential to drive conservation among consumers and firms.

In addition, benchmarking methodologies facilitate the formulation and delivery of mitigation policies. For example, the UK used benchmarking to determine the allocations for new installations in the first phase of the EU ETS, and extended the methodology to incumbent large electricity producers in phase II. Under this approach, plants received emissions rights based on their capacity, output, and the carbon intensity of the particular generating technology. Individual emission rights were then reduced by a common factor calculated to meet the sector-wide cap. This provides an alternative approach to the allocations based on either the historic or projected emissions from individual installations (see Chapter 15 for issues on trading schemes and allocations).

In addition, benchmarking can be instrumental in determining a baseline upon which to formulate voluntary agreements (see Box 23.6 on the 1000 enterprises scheme in China), or establish an accreditation process under any technology based application of the CDM (see Box 23.5).

Information provision, in conjunction with policies to deliver appropriate energy pricing, has strong potential to elicit energy savings. However, realising this requires effective intervention targeted across a broad range of sectors and economic activities.

17.5 Policy responses: Financing Mitigation

Investment by the private sector in efficiency measures is central to raising efficiency; governments have a limited but important role in supporting this.

Private investment is key to transforming the efficiency of energy-using markets. Generally speaking, if energy efficiency measures have a positive net present value there is little case for governments to intervene directly in their financing. For example, it should be a decision for energy supply companies whether to invest in facilitating demand reductions among customers or additional generating capacity depending on assessments of relative cost effectiveness.

In general, it is preferable to tax negative externalities rather than subsidise preferable outcomes.[50] Where possible, it is desirable to foster solutions to barriers or market imperfections, such as capital or technology market failures, at source for example, through markets for insurance or microcredit.[51] However, where such options are not available, carefully targeted provision of direct financial incentives such as loans, subsidies, and tax rebates are appropriate, in particular where:

- *Capital market failure*: Households or firms face a shortage or lack of access to capital. This may be particularly relevant to poorer households and to firms in developing countries (see Chapter 23 in relation to financing international energy

[48] Caron Trust Annual Report 2005/6: www.carbontrust.co.uk Readers should also note active support for energy efficiency by the Energy Savings Trust. Information available at http://www.est.org.uk/

[49] http://www.fco.gov.uk/Files/kfile/PostG8_Gleneagles_Communique,0.pdf

[50] The costs of subsidies, for example, may be increased by the tendency for households or firms to take advantage of financial support for a particular energy efficiency measure who would have invested without the additional incentive: see Box 17.1.

[51] Microcredit is a form or finance designed to target poor people without sufficient collateral to have access to affordable private capital. See Yunus, M., Banker to the Poor: Micro-Lending and the Battle Against World Poverty

efficiency). Alternatively, larger scale private investment, for example in major infrastructure projects, may be limited due to long return periods or a lack of credibility in carbon markets:

- *Technology market failure*: Support may significantly reduce long run technology costs. For example, direct support for next generation lighting technologies or micorgeneration technologies may increase the overall emissions reduction potential of the buildings sector by promoting economies scale markets and encouraging innovation for these technologies;

- *Delivery of wider policy objectives*: Financial support can create opportunities to deliver wider climate-related or social policy objectives. For example, in providing financial incentives, for example on building insulation, it may also be possible deliver information on a wider range of technologies such as advanced window glazing or lighting control systems. Alternatively, revenue from energy taxation or trading schemes may be used to overcome distributional and other perverse effects of policy.

There are examples in which incentives such as loans, subsidies, and tax rebates by public bodies, non-governmental organisation or energy suppliers have delivered significant energy savings: US demand side management programmes (of which the majority are financial incentives), for instance, saved approximately $1.78 billion of energy in 2000. This is at a cost equivalent to 3.4 cents kWh (less than half of the cost of end use consumption).[52] The Carbon Trust offers interest-free loans to small and medium sized firms in the UK to purchase energy efficient equipment. These realised 25 kT of CO2 reductions in 2005/6 at a lifetime programme cost of £9 t/C02.[53] Box 17.7 outlines an example in which information provision and financing support can help overcome barriers to reducing emissions from agriculture.

Box 17.7 Support for Deployment of Anaerobic Digesters in US Agriculture

Anaerobic digesters store manure and allow it to decay in the absence of oxygen, producing biogas (a mixture of methane and CO2) which can be captured and combusted as an alternative to fossil fuels. Furthermore, heat generated in the process can be used, for example, to warm water or livestock units. The digestion process may also increase the value of the manure as a fertiliser.

Barriers to the uptake of this technology include upfront investment costs (estimated to be $500-600/cow)[54]; lack of information about the technology; high transaction costs associated with using the biogas as a power source; and planning regulations on the building of anaerobic digestors.

In the US, the AgSTAR programme encouraged the adoption of this technology by providing information to farmers.[55] State and federal funding was also made available in the form of interest subsidy payments, tax exemptions and loans.[56] In the last two years, the number of digesters in the US has more than doubled, reducing emissions by 0.6 MtCO2e annually and generating 120 million kWh of energy.[57]

Specialist management by energy service companies has the potential to reduce the cost of conserving energy among both private and public sector organisations (compared to a direct delivery mechanism). This is set out in Box 17.8 below.

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[52] Gillingham, Newell and Palmer (2004). Statistic assumes all energy saved is electricity and includes utility costs only.
[53] Caron Trust Annual Report 2005/6: www.carbontrust.co.uk
[54] Minnesota Project (2002) Final report: Haubenschild Farms Anaerobic Digester: http://www.mnproject.org/pdf/Haubyrptupdated.pdf
[55] EPA AgSTAR Program, www.epa.gov/agstar
[56] EPA AgSTAR Funding on-farm biogas recovery systems: a guide to federal and state resources: http://www.epa.gov/agstar/pdf/ag_fund_doc.pdf
[57] EPA "AgSTAR digest winter 2006" http://www.epa.gov/agstar/pdf/2006digest.pdf

Box 17.8 Energy service contracting

Energy service contracting is a form of financial market transformation in which responsibility for designing, managing, or financing energy-using processes is outsourced to a third party (commonly known as an energy service company). In return, the company receives direct payment or a share of the financial benefits of delivered energy savings.

Energy service contracting can reduce energy costs by employing economies of scale and specialisation to overcome failures and barriers both within, and external to, industrial, commercial, public sector clients and, occasionally, households. Individual contracts vary widely but service companies may undertake audits, invest, install and/or manage energy systems.

Energy service markets are well established in countries such as the US, Germany and Austria. They are difficult to define but it is estimated that the US energy services industry has brought $8-15billion in net benefits.[58] In London, energy service contracting is at the heart of urban planners strategy to deliver low carbon energy solutions.[59]

Policy makers create the conditions for these markets to develop by: encouraging efficient energy and carbon markets, enabling service companies to access markets in public sector efficiency and by acting to facilitate local availability of capital (see Chapter 23 in relation to financing international efficiency).

Public sector investment in energy conservation has the potential to both reduce emissions and save public money

Public authorities are commonly the largest energy consumers in an economy, typically 10–20% of gross domestic product in both industrial and developing countries and a similar share of building floor space, energy use, and greenhouse gas emissions.[60]

There is widespread potential for cost-effective energy conservation across government buildings and state owned industrial facilities. For example, the public sector emits approximately 11% of the UK's total carbon emissions, and it is estimated that over 13% of this could be saved in a cost effective way.[61]

Raising energy efficiency in the public sector can both save public money and reduce emissions. In addition, there may be indirect benefits through fostering innovation and change across the supply chain, and demonstrating the desirability of, and potential for, action to wider society. Woking is an example of how effective this can be Box 17.9).

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[58] Goldman et al (2005). Figure dependent on choice of discount rate.

[59] The London Climate Change Agency recently established the London ESCO, a public/private joint venture energy service company, with EDF Energy to deliver a range of planned mitigation projects, including the zero carbon development project recently announced by the Mayor. See: http://www.london.gov.uk/mayor/environment/energy/climate-change/edf-energy.jsp and *http://www.lcca.co.uk* .

[60] Harris *et al.*, (2005, 2004, 2003)

[61] Carbon Trust (2005). Figures valid for 2002 based on a discount rate of 15% which is higher than the appropriate discount rates currently identified in the 'Green Book'.

Box 17.8 Woking Borough Council

Woking Borough Council is at the forefront of local authority efforts to tackle climate change in the UK.[62] In 2002, the Council adopted a comprehensive Climate Change Strategy designed to reduce greenhouse gas emissions, adapt to climate change, and promote sustainable development.

Between 1991 and March 2005, the Council's policies reduced energy consumption by almost 51% and carbon dioxide emissions by 79% across its own buildings. Between, March 2004 and March 2005, the Council purchased 82% of its electrical and thermal energy requirements from sustainable sources.

In 1999, the Council established an energy services company, Thameswey Energy Ltd., in conjunction with a commercial business partner, to finance sustainable and renewable energy projects. It has been instrumental, for example, in enabling the Council to install the town centre Combined Heat and Power station, which provides electricity, heat and power to the Civic Offices, the Holiday Inn Hotel and a number of other town centre customers. The Council also has a number of PV projects, accounting for approximately 10% of the UK's total installed capacity.

Woking Council is taking a leading role in promoting energy conservation and reducing carbon intensity across the municipality. It sponsors an energy efficiency advice centre, which provides free energy saving advice to residents. Furthermore the Council is currently investigating, in conjunction with Thameswey Ltd., the potential to deliver a number of wind turbines installations together with 1,000 low carbon homes with embedded micro generation across the Borough.

However, many of the barriers outlined in the earlier part of this chapter apply to the public sector, including capital constraints, information failures, landlord-tenant incentive failures, as well as institutional and behavioural barriers. Key issues in raising public sector efficiency include:

- *Allocating resources and overcoming capital constraints:* Short-term budgeting processes in the public sector may hinder the delivery of energy efficiency. Private sector energy contracting may also be useful in leveraging private investment in the public sector (see Box 17.9 for examples of such partnerships in London and Woking);

- *Establishing targets on energy efficiency:* As in the private sector, high-level targets can overcome behavioural and institutional barriers by focusing management attention and establishing accountability for delivery. Grading and comparisons between government departments and public organizations can further promote this competitive dimension;

- *Driving efficiency through public sector reform:* Reform of public services and state-owned enterprises, including the closure of inefficient facilities or their merging under more effective management, can directly drive energy efficiency. Examples include industrial restructuring and consolidation in China's iron and steel industry, and the power sector reforms discussed in Chapter 12;

- *Coordinated investment and planning of infrastructure and energy systems:* Coordinating systems such as water, waste, transport, and power can achieve energy savings. For example, planners in London are introducing cooling systems onto the underground network using absorption chilling technologies which convert waste heat from the buildings above;

[62] See the Councils climate change strategy for further information. http://www.woking.gov.uk/environment/climatechangestrategy/climatechange.pdf

- *Driving efficiency through procurement:* Governments are major procurers of energy using products (the US federal government alone accounts for 10% of the total market for energy using products).[63] Purchasing life-cycle cost-effective products reduces future public expenditure, as well as fostering innovation and driving the wider market in energy efficient products (see Box 17.10).

Box 17.9 Driving Efficiency through Procurement

Since 1999, US guidelines have been in place requiring federal agencies to purchase Energy Star products over alternatives and, in product categories not covered by the endorsement scheme, only those products in the upper 25% of the distribution of efficiencies in the product class. It is estimated that this commitment will save between $160 and $620 million (or between 3% and 12% of total energy use in federal buildings) by 2010.[64] The size of the federal market delivers high participation rates among manufacturers: an estimated 95% of monitors, 90% of computers and almost 100% of printers sold are Energy Star compliant.[65]

Several US state and municipal governments have helped fuel market changes by adopting the federal efficiency criteria for their own purchases. If agencies at all levels of government adopt these same criteria, estimated electricity savings in the US would be 18 TWh/year, allowing government agencies (and taxpayers) to save at least US$1 billion/year on their energy bills.[66]

The PROST study concluded that, for the EU as a whole, public sector investments of about €80 million/year in program management and incremental purchase costs for buying energy-efficient products could reduce annual government energy costs by up to €12 billion/year.[67]

17.6 Policy Delivery

Effective policy appraisal, design, implementation and management is essential in keeping down the costs and maximizing the effectiveness of policies to promote energy efficiency to firms, consumers and governments

This section outlines general principles of policy delivery which help to reduce the costs to consumers, firms and governments and raise the effectiveness of polices to promote energy efficiency. In particular, it focuses on issues relating to the delivery of energy efficiency labelling, certification and endorsements as well as performance standards. Key principles are:

- *Effective policy signalling:* Paradoxically, the mark of a low-cost policy action is often the absence of an observable step-change in market behaviour, where planning, investment and market delivery mechanisms are allowed to respond, within normal economic cycles and in advance of the enforcement date. Good policy communication is essential to this process. Evidence of pre-commitment, perhaps in the form of voluntary agreements, throughout the supply chain indicates market preparedness. For example, transparent USA/ EU negotiations to revise Energy Star specifications for information and communication technologies (ICT), supported by a well informed dialogue with industry and experts on the technical potential, is expected to result in a very high level of compliance (with minimal impact on the price of new equipment) in advance of the new standards coming into force in Summer 2007;

- *Policy appraisal and prioritisation:* Thorough engineering, market and economic assessments of the likely costs and benefits of individual policy approaches enable

[63] Gillingham, Newell and Palmer (2004)
[64] Harris and Johnson (2000) Harris et al (2005)
[65] Webber et al. (2004)
[66] Harris and Johnson, (2000)
[67] Harnessing the Power of the Public Purse: Final report from the European PROST study on energy efficiency in the public sector http://195.178.164.205/library_links/downloads/procurement/PROST/PROST-fullreport.pdf

strategic decisions on policy priorities.[68] Many product markets, such as those for appliances or ICT, are extremely dynamic, requiring regular re-appraisal of policy priorities. For example, the EU market for mobile phones has grown from hundreds of thousands to tens of millions in just a few years. Policy makers will need to respond to the challenge of rapid growth in demand for products such as: ICT technologies, power supplies, and digital television reception platforms ('set top boxes');

- *Monitoring and flexibility:* Careful and regular evaluation helps sustain a positive balance of costs and benefits throughout the lifecycle of a policy. As set out in Chapter 15, a degree of flexibility is required at the design stage to allow for a response to changing circumstances; for example, as a result of the success of the EU labelling scheme on refrigerators outlined in Box 17.5, the market is now saturated with 'A' performance graded products requiring the introduction of A+, A++ performance classifications;

- *Verification and reporting:* Well-defined testing protocols and procedures are particularly important foundations for the implementation of labels, endorsements and standards. Sound verification processes are essential to maintain policy credibility among producers, intermediaries, consumers and governments. For example, poor compliance is commonly cited as the key barrier increasing energy savings from building regulations, particularly in the developing world and transition economies where supporting institutional frameworks are typically weaker.

Policies can be mandatory, the subject of a voluntary agreement between public authorities and industry, or industry led. None of these approaches is universally preferable or appropriate. Regulatory policies may depend on the tacit agreement of industry and end-users. Voluntary strategies typically depend on implicit of explicit policy commitments to support the desired market transition, for example by regulatory underpinning or other sanctions. The choice of implementing strategy depends on:

- *Political culture of the implementing country:* public authorities often prefer to mandate policy to increase certainty around policy delivery. However, countries such as Japan have a strong culture of implementing policy based on voluntary consensus, which has been successful in ensuring high compliance with its Top Runner programme (see Box 17.2);

- *Market structure:* Voluntary agreements may be more readily achievable where capacity is concentrated among relatively few producers or retailers (and where there is some form of recognition of that commitment by government in its broader policy). For example, an EU voluntary agreement on set top boxes[69] has been successful in raising energy efficiency of satellite and cable platforms following support from major service providers. However less complete coverage of the more disparate market for freeview platforms, coupled with tough price competition, has resulted in relatively weaker improvements in standby and operating performance;

- *Implementation cost:* Regulatory approaches may be expensive to implement in some sectors. In agriculture, for instance, enforcement of regulations could be costly because sources of emissions are diffuse. Developing countries, in particular, may not have resources to establish or strengthen the required institutional structures or allocate appropriate resources more generally. However, the long run costs of inaction are often higher;

- *Timing:* Voluntary or industry led agreements may be quicker to implement, which may be useful where product markets are growing quickly or unexpectedly. Regional or international action may take longer to organize than national action, but may be

[68] Understanding this balance requires consideration of the risk of perverse incentives. For example, regulations which become stricter over time may delay the retirement of inefficient plant by making new installations relatively more expensive. See for example, Maloney and Brady (1988), Nelson et al. (1993), Stewart (1981), Gollop and Roberts (1983), McCubbins et al (1989). However, such secondary barriers may be correctable by, for example, suitable fiscal instruments.

[69] The EU Code of Conduct for Digital Television Systems 2003

more powerful. Government objectives may be delivered faster and more efficiently by participating in and influencing established co-operative structures (for instance EU adoption of certain Energy Star protocols – see Box 17.4 for an outline of Energy Star and Chapter 24 for details on international policy management);

- *Delivery risk:* Information asymmetries between firms and governments on the costs and potential for innovation mean that voluntary and industry led measures may not achieve the full cost effective energy savings potential.[70] Investment in data collection help support more ambitious, cost-effective policy.[71]

The IEA publication on 'Labels and Standards' (2000) provides a useful outline of key principles and steps for developing policy while its report entitled 'Cool Appliances: Policy Strategies for Energy-Efficient Homes' (2003) is an excellent guide to consumer product markets. International aspects of the design, implementation and monitoring of tests and standards are outlined in Chapter 24).

17.7 Building a shared concept of responsible behaviour

Individual preferences play a key role, both in shaping behaviour, and in underpinning political action

Most of economics assumes that individuals have fixed preferences and systems of valuations. It then examines policy largely in terms of 'sticks' and 'carrots', with the objective to increase welfare relative to this given set of preferences. This theory is powerful and central to most of the analysis of this Review, however it does not reflect the whole story.

Much of public policy is actually about changing attitudes. In particular, there are two broad areas where policy makers may focus in the context of climate change: seeking to change notions of responsible behaviour, and promoting the willingness to co-operate. Examples of the former in other areas include policies towards pensions, smoking and recycling while those of the latter include neighbourhood watch schemes on crime and community services more generally.

In the case of climate change, individual preferences play a particularly important role. Dangerous climate change cannot be avoided solely through high level international agreements; it will take behavioural change by individuals and communities, particularly in relation to their housing, transport and food consumption decisions.[72] There is clear evidence of shift towards environmentally and socially responsible consumption and production. For example, global sales of Fairtrade products increased by 37% to €1.1 billion in 2005.[73]

The actions and attitudes of individuals also matter when it comes to international collective action by governments. The most important force that will generate and sustain this action is domestic political demand in the key countries or regions (see Chapter 21 for discussion of collective action issues). Policies should therefore aim to create a shared understanding of the key issues. This is again an area where "policy" cannot be confined to the sticks/carrots and structural analysis standard in economics, although to emphasise once more that these approaches are absolutely crucial and, indeed, underlie most of the policy analysis of this report.

Refusing to move the argument beyond one of 'sticks' and 'carrots' would miss much that is important to policy formation on climate change. Alongside the influence of preferences in the community, leadership by governments, businesses and individuals is important in demonstrating how change is possible.

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[70] Cadot and Sinclair-Desgagne (1996) developed a game theoretic model solution for setting performance targets given asymmetric information regarding cost of technological advance.
[71] IEA/OECD (2003) Estimated data collection costs of approximately $1million to support revision of performance standards per product class.
[72] See 'I will if you will: towards sustainable consumption', a report by the Sustainable Development Commission. http://www.sd-commission.org.uk/publications/downloads/I_Will_If_You_Will.pdf
[73] Fairtrade Organisation Annual Report 2005: http://www.fairtrade.net/fileadmin/user_upload/content/FLO_Annual_Report_05.pdf

Governments can help shape preferences and behaviour through education, persuasion and discussion

Crude attempts by government to "tell people what's best for them" tend to fail, and in any case raise ethical problems (see Chapter 2). The acceptability of "persuasion" requires public debate.[74] This dialogue may involve a range of actors, including the public sector, communities and individuals, NGOs, the media, and business. The public authorities can play a key role in helping to bring these elements together. For "government by discussion" as advocated by John Stuart Mill to work well, evidence and balanced argument which cuts through the complexity are crucial.

Polices designed to change preferences raise issues around the moral authority for action. There are examples of unacceptable public actions, such as deliberate misinformation in propaganda campaigns. However, most would view action to promote the understanding of climate change as appropriate – and, in fact, would view a failure to do so as irresponsible. This requires bringing to public attention the interests of those who might be ignored, such as future generations and those in poorer countries, and thinking through consequences of actions, as opposed to advancing the interests of narrow groups or excluding sections of the population.

The way in which issues and responses are communicated is critical. However, evidence suggests that people often see climate change discourse as confusing, contradictory and chaotic:[75] some approaches are alarmist, emphasising the scale of the problem (often rightly) but failing to acknowledge the potential for real action in response; others cast doubt on the human causes of climate change or optimistically assume that no response is necessary (Box 21.6 outlines public attitudes to climate change internationally.

Effective climate change discourse creates the conditions for positive behaviours by:

- Clear exposition of the existence and causes of the problem;
- Emphasising the potential for action using simple, positive messages. In particular, by tackling the disparity between the scale of the problem and the potential actions of households and firms so that the necessity of individual responses is broadly understood;
- Targeting groups which share values (rather than demographics), working with individuals and community leaders to disseminate key messages, and using both evidential and moral arguments to engage people.

Ultimately, climate friendly behaviour will have to become well understood and highly valued (not simply the subject of campaign issues) in order for it to become a mass phenomenon.

Schools have an especially important role. Educating people from an early age about how our actions influence the environment is a vital element in promoting responsible behaviour. Creative and practical ways can be found to help pupils translate the study of climate change into actions in their everyday lives. For instance, practical examples of sustainability, such as installing wind turbines in school grounds, can help to provide pupils both with an understanding of the consequences of their actions and a tangible example of how behaviour, incentives and technologies can provide solutions.

Responsible behaviour can be encouraged through leadership

Building a shared understanding of the problem, and of what responsible action means, is a key element in action. Leadership by the public sector, business, investors, communities and individuals can provide reassurance not only that action is possible, but also that it often has wider financial and other benefits.

[74] See John Stewart Mill, 'On Liberty', where he advocated an approach to democracy based on government by discussion.
[75] See report commissioned by the Institute of Public Policy Research entitled, 'Warm Words: How are we telling the climate story and can we tell it better?' http://www.ippr.org.uk/publicationsandreports/publication.asp?id=485

Actions by central, regional and local governments and cities can have important demonstration effects that can be influence wider action, both by other governments and by the general public. Box 17.11 outlines California as an example of an administration which has deliberately positioned itself as a leader, both in order to gain economic advantage through efficiency gains and technology development, and to inspire action both by its citizens and elsewhere.

Box 17.10 California: treating energy efficiency as a resource

California is the sixth largest economy in the world and has a long history of successful energy efficiency and conservation programs including building and appliance standards, and demand side reduction by the state's investor-owned and publicly owned utilities. This has resulted in lower energy intensity compared with other states or the country as a whole. Many of California's policies have been forerunners to federal government interventions establishing, for example, the nation's first standards for residential and non-residential buildings in 1978.

As of 2004, the state's Building and Appliance Standards and energy efficiency incentive and education programs have cumulatively saved more than 40,000 GWh of electricity and 12,000 MW of peak electricity, equivalent to 24 500 MW power plants. This has also increased fuel security, improved the competitiveness of its businesses, and saved consumers money.

In 2004, the California authorities adopted a set of aggressive energy conservation goals designed to help save the equivalent of 30,000 GWh between 2004 and 2013. If achieved, this would meet up to 59% of the investor-owned utilities' additional electricity requirements, and increase natural gas savings by 116% over the period.

To help support the delivery of these goals, the authorities have significantly increased allocations of public funding for cost effective energy efficiency programs to reduce peak electricity demand and increase natural gas efficiency. In addition, new appliance and building standards were introduced in 2005.[76]

A rapidly growing number of businesses are taking action on climate change policy. As discussed in Chapter 12, many are motivated by the desire to combine environmental responsibility and business profitability by increasing the energy efficiency of their business operations, or entering fast-growing environmental technology markets. The Carbon Disclosure Project provides evidence of a growth in the desire of businesses to report carbon footprints to investors.[77]

Many are also deliberately positioning themselves as leaders in this area. This may be driven by a desire to demonstrate responsible behaviour to the public and investors and use their leadership position to influence both government policy the conditions in which other businesses operate. For example, the Corporate Leaders Group on Climate Change recently called upon the UK Prime Minister to take bold steps to reduce climate change.[78]

Investors can also be a powerful voice for responsible action by businesses. The Socially Responsible Investment (SRI) movement grew out of a desire from individuals and organisations such as churches to invest their money in a way compatible with their own beliefs about what responsible behaviour means. Funds managed using some element of SRI principles have grown rapidly, with US assets under management totaling $2.29 trillion, almost 10% of assets under management in that country.[79]

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[76] Californian Energy Commission (2005)
[77] Complete responses of GHG emissions from the world's largest 500 companies were up from 59% in 2005 to 71% in 2006. Carbon Disclosure Report 2006: http://www.cdproject.net/download.asp?file=cdp4_ft500_report.pdf
[78] http://www.cpi.cam.ac.uk/bep/clgcc/downloads/pressrelease_2006.pdf
[79] Social Investment Forum, January 2006: http://www.socialinvest.org/areas/news/2005Trends.htm. This figure includes funds which involve at least one of the following elements: screening, shareholder engagement, and community investment.

More recently, concerns about how businesses treat social, ethical and environmental issues have become a more mainstream issue for investors, with a growing appreciation that failing to take account of these risks can directly threaten a company's financial health and reputation, for example, California state administration recently filed a law suit against 6 major vehicle manufacturers for alleged contributions to climate change. Organisations such as the Investor Network on Climate Risk in the US, and the Institutional Investor Network on Climate Change, have brought together concerned investors to have a dialogue with businesses on how they are responding to the challenge of climate change, and to encourage those who have neglected the issue so far to give it their active consideration.

17.8 Conclusion

Widespread failures and barriers in many relevant markets result in significant untapped energy efficiency potential in the buildings, transport, industry, agriculture and power sectors. These obstacles mean it is necessary to go beyond policies to establish carbon markets and encourage technological research, development and diffusion.

Regulation can stimulate innovation by reducing uncertainty for innovators; encourage investment by increasing the costs and commercial risks of inaction for firms; reduce technology costs by facilitating scale economies, and influence more efficient outcomes in markets such as buildings, transport and energy using products. Policies to promote information, for example through labels, education programmes or technologies such as smart meters and real time displays, can encourage and develop capacity among households and firms to change their behaviour or make investments in energy savings.

Private investment is key to transforming the efficiency of energy-using markets. Generally, policy should seek to tax negative externalities rather than subsidise preferable outcomes, and address the source of market failures and barriers wherever possible (although there are cases for limited direct financial support to firms and individuals). Investment in public sector energy conservation can reduce emissions, improve public services, foster innovation and change across the supply chain and set an example to wider society.

Individual preferences play a key role, both in shaping behaviour and demand for goods and services affecting the environment, as well as in underpinning political action. Public policy on climate change should seek to change notions of what responsible behaviour means, and promote the willingness to co-operate. Education and promotion of clear discourse on the potential risks, costs and benefits together with leadership by the governments, businesses, investors, communities and individuals on the potential for action is critical.

References

The general reader seeking an overview of markets for energy efficiency should refer to the IEA's *Energy Technology Perspectives 2006,* which provides extensive information about failures and barriers, technological solutions, and policy options in sectors such as buildings, transport and industry. The Carbon Trust's publication for the UK Climate Change Programme, *The UK Climate Change Programme: Potential Evolution for Business and the Public Sector,* also provides a useful framework for understanding energy efficiency in different markets which can be applied more broadly. Chapter 6 of Michael Hanneman's M*anaging Greenhouse Gas Emissions in California*, informs the reader on a range of issues relating to energy efficiency including the debate between economists advocating market failures versus market barriers as a basis for policy intervention. The IEA's publication, the *experience of energy saving policies and programmes in IEA countries: learning from the critics,* highlights many of the criticisms commonly leveled at policies to promote energy efficiency and provides a useful introduction to more policy focused literature.

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