12 Opportunities and Wider Benefits from Climate Policies

Key Messages

The transition to a low-emissions global economy will open many new opportunities across a wide range of industries and services. Markets for low carbon energy products are likely to be worth at least $500bn per year by 2050, and perhaps much more. Individual companies and countries should position themselves to take advantage of these opportunities.

Financial markets also face big opportunities to develop new trading and financial instruments across a broad range including carbon trading, financing clean energy, greater energy efficiency, and insurance.

Climate change policy can help to root out existing inefficiencies. At the company level, implementing climate policies can draw attention to money-saving opportunities. At the economy-wide level, climate change policy can be a lever for reforming inefficient energy systems and removing distorting energy subsidies on which governments spend around $250bn a year.

Policies on climate change can also help to achieve other objectives, including enhanced energy security and environmental protection. These co-benefits can significantly reduce the overall cost to the economy of reducing greenhouse gas emissions. There may be tensions between climate change mitigation and other objectives, which need to be handled carefully, but as long as policies are well designed, the co-benefits will be more significant than the conflicts.

12.1 Introduction

Climate change policies will lead to structural shifts in energy production and use, and in other emissions-intensive activities. Whilst the previous chapters focused on the resource costs and competitiveness implications of this change, this chapter considers the opportunities that this shift will create. This is discussed in Section 12.2.

In addition, climate change policies may have wider benefits, which narrow cost estimates will often fail to take into account. Section 12.3 looks at the ways in which climate change policies have wider benefits through helping to root out existing inefficiencies at the company or country level.

Section 12.4 considers how climate policies can contribute to other energy policy goals, such as enhanced energy security and lower air pollution. Conversely, policies aimed at other objectives can be tailored to help to make climate change policies more effective. Energy market reform aimed at eliminating energy subsidies and other distortions is an important example, and is considered in Section 12.5.

In other areas, there may be tensions. The use of coal in certain major energy-using countries, for instance, presents challenges for climate change mitigation – although the use of carbon capture and storage can sustain opportunities for coal. Climate change mitigation policies also have important overlaps with broader environmental protection policies, which are discussed in Section 12.6.

Thinking about these issues in an integrated way is important in understanding the costs and benefits of action on climate change. Policymakers can then design policy in a way that avoids conflicts, and takes full advantage of the significant co-benefits that are available.

12.2 Opportunities from growing markets

Markets for low-carbon energy sources are growing rapidly

Whilst some carbon-intensive activities will be challenged by the shift to a low-carbon economy, others will gain. Enormous investment will be required in alternative technologies and processes. Supplying these will create fast-growing new markets, which are potential sources of growth for companies, sectors and countries.

The current size of the market for renewable energy generation products alone is estimated at $38 billion, providing employment opportunities for around 1.7 million people. It is a rapidly growing market, driven by a combination of high fossil fuel prices, and strong government policies on climate change and renewable energy. Growth of the sector in 2005 was 25%[1].

Within this overall total, some markets are growing at an even more rapid rate. The total global installed capacity of solar PV rose by 55% in 2005, driven by strong policy incentives in Germany, Japan and elsewhere[2], and the market for wind power by nearly 50%[3]. The market capitalisation of solar companies grew thirty-eightfold to $27 billion in the 12 months to August 2006, according to Credit Suisse[4]. Growth in biofuels uptake was not quite as rapid, but there was still a 15% rise to 2005, making the total market over $15 billion.

Growth rates in these markets will continue to be strong, creating opportunities for business and for employment opportunities.

Looking forward, whilst some of these very rapid rates may not be sustained, policies to tackle climate change will be a driver for a prolonged period of strong growth in the markets for low-carbon energy technology, equipment and construction. The fact that governments in many countries are also promoting these new industries for energy security purposes (Section 12.5) will only strengthen this effect.

One estimate of the future market for low-carbon energy technologies can be derived from the IEA's Energy Technology Perspectives report. This estimates the total investment required in low-carbon power generation technologies in a scenario where total energy emissions are brought back down to today's levels by 2050[5]. It finds that cumulative investment in these technologies by 2050 would be over $13 trillion, accounting for over 60% of all power generation by this date. The annual market for low-carbon technologies would then be over $500bn per year. Other estimates are still higher: recent research commissioned by Shell Springboard suggests that the global market for emissions reductions could be worth $1 trillion cumulatively over the next five years, and over $2 trillion per year by 2050.[6]

The massive shift towards low-carbon technologies will be accompanied by a shift in employment patterns. If it is assumed that jobs rise from the current level of 1.7 million in line with the scale of investment, over 25 million people will be working in these sectors worldwide by 2050.

Climate change also presents opportunities for financial markets

Capital markets, banks and other financial institutions will have a vital role in raising and allocating the trillions of dollars needed to finance investment in low-carbon technology and the companies producing the new technologies. The power companies will also require access to large, long-term funds to finance the adoption of new technology and methods, both

[1] REN21 (2006).
[2] Renewables Global Status Report, 2006 update: REN21.
[3] Clean Edge (2006).
[4] Quoted in Business Week, "Wall Street's New Love Affair", August 14 2006.
[5] This investment excludes the transport sector, but includes nuclear, hydropower, and carbon capture and storage.
[6] Shell Springboard (2006). This is an estimate of total expenditure on carbon abatement, and so would include all emission reduction sources. Figures are based on a central scenario.

to conform to new low-carbon legislation and to satisfy rising global power demand from growing populations enjoying higher living standards.

The new industries will create new opportunities for start-up, small and medium enterprises[7] as well as large multinationals. Linked to this, specialist funds focusing on clean energy start-ups and other specialist engineering, research and marketing companies are emerging. Clean technology investment has already moved from being a niche investment activity into the mainstream; clean technology was the third largest category of venture capital investment in the US in the second quarter of 2006[8].

The insurance sector will face both higher risks and broader opportunities, but will require much greater access to long-term capital funding to be able to underwrite the increased risks and costs of extreme weather events[9]. Higher risks will demand higher premiums and will require insurance companies to look hard at their pricing; of what is expected to become a wider range of weather and climate-related insurance products[10].

The development of carbon trading markets also presents an important opportunity to the financial sector. Trading on global carbon markets is now worth over $10bn annually with the EU ETS accounting for over $8bn of this[11]. Expansions of the EU ETS to new sectors, and the likely establishment of trading schemes in other countries and regions is expected to lead to a big growth in this market. Calculations by the Stern Review as a hypothetical exercise show that if developed countries all had carbon markets covering all fossil fuels, the overall market size would grow 200%, and if markets were established in all the top 20 emitting countries, it would grow 400% (the analysis behind these numbers can be found in Chapter 22).

This large and growing market will need intermediaries. Some key players are set out in Box 12.1. The City of London, as one of the world's leading financial centres, is well positioned to take advantage of the opportunities; the most actively traded emissions exchange, ECX, is located and cleared in London, dealing in more than twice the volume of its nearest competitor[12].

[7] See, for instance, Shell Springboard (2006).
[8] Cleantech Venture Network (2006).
[9] Salmon and Weston (2006).
[10] See Ceres (2006) .
[11] World Bank (2006a).
[12] CEAC (2006).

Box 12.1 Financial intermediaries and climate change

The transition involved in moving to a low-carbon economy creates opportunities and new markets for financial intermediaries. Emissions trading schemes in particular require a number of key financial, legal, technical and professional intermediaries to underpin and facilitate a liquid trading market. These include:

Corporate and project finance: trillions of dollars will be required over the coming decades to finance investments in developing and installing new technologies. Creative new financing methods will be needed to finance emission reduction projects in the developing world. And emissions trading will require the development of services needed to manage compliance and spread best practice.

MRV services (monitoring, reporting and verification): these are the key features for measuring and auditing emissions. MRV services are required to ensure that one tonne of carbon emitted or reduced in one place is equivalent to one tonne of carbon emitted or reduced elsewhere.

Brokers: are needed to facilitate trading between individual firms or groups within a scheme, as well as offering services to firms not covered by the scheme who can sell emission reductions from their projects.

Carbon asset management and strategy: reducing carbon can imply complex and inter-related processes and ways of working at a company level. New opportunities will arise for consultancy services to help companies manage these processes.

Registry services: these are needed to manage access to and use of the registry accounts that hold allowances necessary for surrender to the regulator.

Legal services: these will be needed to manage the contractual relationships involved in trading and other schemes.

Trading services: the transition to a low carbon economy offers growing opportunities for trading activities of all kinds, including futures trading and the development of new derivates markets.

Companies and countries should position themselves now to take advantage of these opportunities

There are numerous examples of forward-looking companies which are now positioning themselves to take advantage of these growth markets, ranging from innovative high-technology start-up firms to some of the world's largest companies.

Likewise, governments can seek to position their economy to take advantage of the opportunities. Countries with sound macroeconomic management, flexible markets, and attractive conditions for inward investment can hope to win strong shares of the growing clean energy market. But particular countries may also find that for historical or geographical reasons, or because of their endowment of scientific or technical expertise, they have advantages in the development of particular technologies. There may be grounds for government intervention to support their development, particularly if promising technologies are far from market and needs to be scaled up to realise their full potential – Chapter 16 discusses how market failures and uncertainties over future policy justify action in this area.

Implementing ambitious climate change goals and policies may also help to create a fertile climate for clean energy companies. Hanemann et. al. (2006) analysed the economic impact of California taking the lead in adopting policies to reduce GHG emissions. They concluded that, if it acts now, California can gain a competitive advantage, by becoming a leader in the new technologies and industries that will develop globally as international action to curb GHG emissions strengthens. They estimate that this could increase gross state product by $60 billion, and create 20,000 new jobs, by 2020.

12.3 Climate change policy as a spur to efficiency and productivity

Climate change policies can be a general spur to greater efficiency, cost reduction and innovation for the private sector

Predictions of the costs of environmental regulations often turn out to be overestimates. Hodges (1997) compared all cases of emission reduction regulations for which successive cost estimates were available, a dozen in total. He found that in all cases except one (CFCs where costs were only 30% below expectations due to the accelerated timetable for phase-out of the chemical), the early estimates were at least double the later ones, and often much greater.

One example is the elimination of CFCs in car air conditioners. Early industry estimates suggested this would increase the price of a new car by between $650 and $1200. By 1997, the cost was $40 to $400[13].

When such numbers come to light, companies are often accused of inflating initial cost estimates to support their lobbying efforts. But there is a more positive side to the story. The dramatic reduction in costs is often a result of the process of innovation, particularly when a regulatory change results in a significant increase in the scale of production.

And the process of complying with new policies may reveal hidden inefficiencies which firms can root out, saving money in the process (Box 12.2).

Box 12.2 Reducing Business Costs Through Tackling Climate Change

An increasing number of private and public sector organisations are discovering the potential to reduce the cost of goods and services they supply to the market. A study of 74 companies drawn from 18 sectors in 11 countries including North America, Europe, Asia, and Australasia revealed gross savings of $11.6 billion, including[14]:

- BASF, the multi-national conglomerate and chemical producer, has reduced GHG emissions by 38% between 1990 and 2002 through a series of process changes and efficiency measures which cut annual costs by 500 million euros at one site alone;

- BP established a target to reduce GHG emissions by 10% on 1990 levels by 2010, which it achieved nine years ahead of schedule, while delivering around $650 million in net present value savings through increased operational efficiency and improved energy management. Between 2001 and 2004, the organisation contributed a further 4MtC of emission reductions through energy and flare reduction projects. $350 million investment in energy efficiency is planned over 5 years from 2004.

- Kodak began tracking its greenhouse gas emissions in the 1990s, and set five-year goals for emissions reductions. To help to achieve this, the company performed short, focused energy assessments – "Energy Kaizens" – across different areas of its business, aimed at reducing waste. Between 1999 and 2003, this and other initiatives resulted in overall savings of $10 million.

Tackling climate change may also have more far-reaching effects on the efficiency and productivity of economies. Schumpeter (1942)[15] developed the concept of "creative destruction" to describe how breakthrough innovations could sweep aside the established economic status quo, and unleash a burst of creativity, investment and economic growth which ushers in a new socio-economic era. Historical examples of this include the introduction of the railways, the invention of electricity, and more recently, the IT revolution. Dealing with

[13] American Prospect, "Polluted Data", November 1997.
[14] The Climate Group (2005).
[15] See also Aghion and Howitt (1999).

climate change will also involve fundamental changes worldwide, particularly to energy systems.

In particular, the shift to low-carbon energy technologies will result in a transformation of energy systems; the implications of this are explored in the following sections.

12.4 The links between climate change policy and other energy policy goals

Climate change policies cannot be disconnected from policies in other areas, particularly energy policy. Where such synergies can be found, they can reduce the effective cost of emissions reductions considerably. There may also be tensions in some areas, if climate change policies undermine other policy goals. But as long as policies are well designed, the co-benefits should outweigh the conflicts.

Climate change and energy security drivers will often work in the same direction, although there are important exceptions

Energy security is a key policy goal for many developed and developing countries alike. Although often understood as referring mainly to the geopolitical risks of physical interruption of supply, a broader definition would encompass other risks to secure, reliable and competitive energy, including problems with domestic energy infrastructure.

Energy efficiency is one way to meet climate change and energy security objectives at the same time. Policies to promote efficiency have an immediate impact on emissions. More efficient use of energy reduces energy demand and puts less pressure on generation and distribution networks and lowers the need to import energy or fuels. For developing countries in particular, who often have relatively low energy efficiency, this is an attractive option. Indirectly, they also help with local air pollution, by limiting the growth in generation.

Improving efficiency within the power sector itself has similar effects. Box 12.3 gives an example of the scale of the potential to reduce emissions from making fossil fuel production processes more efficient.

Box 12.3 Economic opportunities from reducing gas-flaring in Russia

In total, leaks from the fossil fuel extraction and distribution account for around 4% of global greenhouse gas emissions. Within this, gas flaring – the burning of waste gas from oil fields, refineries and industrial plants – accounts for 0.4% of global emissions. Increasingly, there has been a move to capture these gases, driven by economic as much as environmental reasons. This is by no means universal, and in some countries the potential for emissions savings in this area remains significant.

The post-Soviet collapse of Russia's energy-intensive economy cut carbon emissions and left it with a surplus of transferable emission quotas under the Kyoto protocol. Decades of under-investment, however, mean that current 6-7 per cent GDP growth, spurred by higher energy and commodity prices, is both raising emissions and putting pressure on the infrastructure. Sustaining growth requires very large energy and related infrastructure investment. In June 2006 the government approved a $90bn investment programme to replace ageing coal and nuclear generating plants, increase generating capacity and strengthen the grid system.

A recent IEA report[16] on Russian gas flaring, however, indicates that without accompanying price and structural reforms, especially in the gas sector, investment alone is unlikely to deliver the full potential for efficiency gains or reductions in GHGs.

The report indicates that low prices for domestic gas, coupled with Gazprom's monopoly over access to both domestic and export gas pipelines and the high levels of waste and inefficient technology, restrict its ability to satisfy rising export and domestic demand, and to reduce both gas losses and GHG emissions.

In 2004 Gazprom lost nearly 70 billion cubic metres (bcm) of the nearly 700bcm of natural gas which flowed through its network because of leaks and high wastage from inefficient compressors. Gas related emissions amounted to nearly 300 MtCO2e of GHG, including 43 MtCO2e from the 15bcm of gas flared off, mainly by oil companies unable to gain access to Gazprom's pipes. On this basis, Russia accounted for around ten per cent of natural gas flared off globally every year. However, an independent study conducted by the IEA and the US National Oceanic and Atmospheric administration, calibrated from satellite images of flares in the main west Siberian oilfields, indicated however that up to 60bcm of gas may be lost through flaring – over a third of the estimated global total[17].

Gas flaring represents a clear illustration of the potential efficiency gains from new technology linked to more rational pricing policies and other structural reforms. These would also yield significant climate change mitigation benefits.

A more diverse energy mix can be an effective hedge against problems in the supply of any single fuel. As climate change policy tends to encourage a more diverse energy mix, it is generally good for energy security. And conversely, policies carried out for energy security reasons may have benefits for climate change. The expansion of a range of sources of renewable power and, where appropriate, of nuclear energy can reduce the exposure of economies to fluctuations in fossil fuel prices, as well as reducing import dependence.

Coal is an important exception to this rule. Coal is much more carbon intensive than other fossil fuels: coal combustion emits almost twice as much carbon dioxide per unit of energy as does the combustion of natural gas (the amount from crude oil combustion falls between coal and natural gas[18]). Many major energy-using countries have abundant domestic coal supplies, and hence see coal as having an important role in enhancing energy security. China, in particular, is already the world's largest coal producer; its consumption of coal is likely to double over the 20 years between 2000 and 2020[19].

[16] IEA (2006).
[17] IEA (2006).
[18] Energy Information Administration (1993).
[19] Chinese Academy of Social Sciences (2006).

As well as using coal directly for energy production, coal-producing countries including the US, Australia, China and South Africa are investing in coal-to-liquids technology, which would allow them to reduce their dependence on imported oil and use domestic coal to meet some of the demand for transport fuel. But it has been estimated that "well-to-wheel" (full lifecycle) emissions from the production and use of coal-to-liquids in road transport are almost double those from using crude oil[20].

However, extensive deployment of carbon capture and storage (as discussed in Chapter 9), can reconcile the use of coal with the emissions reductions necessary for stabilising greenhouse gases in the atmosphere.

Supporting sufficient investment in generation and distribution capacity also requires a sound framework capable of bringing forward required investment. Clear, long-term credible signals about climate policy are a critical part of this. If there is uncertainty about the future direction of climate change policy, energy companies may delay investment, with serious consequences for security of supply. This is discussed in more detail in Chapter 15.

Access to energy is a priority for economic development

There are currently 1.6 billion people in the world without access to modern energy services[21]. This restricts both their quality of life, and their ability to be economically productive. Providing poor people with access to energy is a very high priority for many developing countries, and can have significant co-benefits in reducing local pollution, as the next section discusses.

Increasing the number of energy consumers, by providing access to energy, would tend to push emissions upwards. But well-designed policies present opportunities for meeting several objectives at once. New renewable technologies, developed with climate change objectives in mind, can help to overcome barriers to access to energy. Microgeneration technologies (see Box 17.3 in Chapter 17) such as small-scale solar and hydropower, in particular, remove the need to be connected to the grid, and so help raise availability and reduce the cost of electrification in rural areas. And as discussed below, the replacement of low-quality biomass energy with modern energy can cut emissions and pollution.

As well as access, affordability is a key issue in both developed and developing countries. Poverty is determined by people's capacity to earn in relation to prices. Energy prices are one significant aspect, along with food and other essentials.

But it is inappropriate to deal with poverty by distorting the price of energy. Addressing income distribution issues directly is more effective. There are a number of ways to achieve this. One is indexing social transfers to a price index, taking account of different consumption patterns of poorer groups in the relevant price index for those groups. Other more direct means include making special transfers to those with special energy needs such as the elderly, and the use of "lifeline tariffs", whereby people using a minimal amount of power pay a sharply reduced tariff for a fixed maximum number of units.

Climate change policies can help to reduce local air pollution, with important benefits for health

Measures to reduce energy use, and to reduce the carbon intensity of energy generation, can have benefits for local air quality. Most obviously, switching from fossil fuels to renewables, or from coal to gas, can significantly the levels of air pollution resulting from fossil fuel burning.

A recent study by the European Environment Agency[22] showed that the additional benefits of an emissions scenario aimed at limiting global mean temperature increase to 2^0C would lead

[20] Well-to-wheels emissions from fuels such as gasoline are around 27.5 pounds of CO2 per gallon of fuel. This compares with 49.5 pounds per gallon from coal-to-liquids, assuming the CO2 from the refining process is released into the atmosphere. See Natural Resources Defence Council (2006).
[21] World Bank, "1.6 billion people still lack access to electricity today", press release, 18 September 2006 .
[22] Air Quality and ancillary benefits of climate change, EEA, Copenhagen, 2006

to savings on the implementation of existing air pollution control measures of €10 billion per year in Europe, and additional avoided health costs of between €16-46 billion per year.

Local air pollution has a serious impact on public health and the quality of life. These impacts are particularly severe in developing countries, where only malnutrition, unsafe sex and lack of clean water and adequate sanitation are greater health threats than indoor air pollution[23]. In China, a recent study[24] showed that for CO_2 reductions up to 10-20%, air pollution and other benefits more than offset the costs of action.

Forthcoming analysis from the IEA (Box 12.4) shows that combustion of traditional biomass for cooking and heating in developing countries is associated with high GHG emissions and adverse indoor air quality and health impacts, which switching to a cleaner fuel could reduce.

Box 12.4 Use of traditional biomass in developing countries

In developing countries, 2.5 bn people depend on traditional biomass such as fuel wood and charcoal as their primary fuel for cooking and heating because it is a cheap source of fuel. The emissions associated with this biomass are relatively high because it is not combusted completely or efficiently. Aside from the climate change impact, combustion of biomass is associated with a range of detrimental effects on health, poverty and local environment including:-

- Smoke from biomass from cooking and heating was estimated to cause 1.3 m premature deaths in 2002. Women and children are most severely affected because they spend most time in the home doing domestic tasks. More than half the deaths are children because their immune systems are poorly equipped to deal with the local air pollution.
- Time spent collecting the biomass is time that could otherwise be spent by women or children in education or other productive work. The collection of biomass may also involve hard physical labour that deteriorates the health of the women and children doing it.
- Collection of biomass causes localised deforestation and land degradation. If animal dung is used as a fuel rather than a fertiliser then soil fertility suffers. The widespread use of fuel wood and charcoal can mean local resources getting used up so people have to travel further to collect it.

Switching away from traditional biomass towards modern, cleaner cooking fuels can save GHG emissions and reduce the health, poverty and local environment concerns outlined above. The UN Millennium Project has adopted a target of reducing by 50% the number of households using traditional biomass as their primary fuel by 2015; this means giving an extra 1.3 bn people access to clean fuels by this date. If this were achieved by switching these users to liquid petroleum gas, it would cost $1.5 bn per year for new stoves and canisters, increase global demand for oil by just 0.7% in 2015, and result in a small reduction in GHG emissions.

Source: IEA (in press).

Sometimes climate change objectives will conflict with local air quality aims. This is a particular issue in transport. In road transport, switching from petrol to diesel reduces CO_2 emissions, but increases local air pollution (PM10 and NOx emissions). High blends of biodiesel can also emit slightly more NOx than conventional diesel. The US and EU are in the process of implementing stronger policies to reduce CO_2 emissions from diesel vehicles, although this will take time to have an effect.

In the case of aviation, there are multiple links between objectives[25]. One of the ways of achieving CO_2 improvements in aircraft is to increase combustion temperatures in engines.

[23] WHO (2006).
[24] Aunan et al (2006)
[25] See European Commission (2005).

However, this increases levels of NOx, an important local air pollutant. Other measures to improve fuel efficiency and CO_2 performance, such as reducing aircraft weight, have benefits for local air pollution. And there are complex relationships between gases emitted at altitude – there are suggestions, for instance, that more modern engines have a greater tendency to produce condensation trails, which intensify warming effects (see Box 15.6, Chapter 15). Further technological advances in aircraft construction will be important in meeting both climate change and air pollution objectives simultaneously.

Policies to meet air pollution and climate change goals are not always compatible. But if governments wish to meet both objectives together, then there can be considerable cost savings compared to pursuing both separately.

12.5 The role of pricing and regulatory reforms in the energy markets

Pricing and regulatory reforms in the energy markets are important both for effective climate change policy, and for long-term productivity and efficiency

Many countries have a long history of subsidising particular fuels: coal, oil, nuclear power, electricity for rural areas, and more recently renewable energy. With the important exceptions of support mechanisms for R&D and innovation (see Chapter 16), these are a source of economic distortion and loss. Furthermore there has been a strong historical bias toward the more polluting fuels. The liberalisation of energy markets that began to take place in many countries in the late 1980s and early 1990s was seen as a means of reducing these subsidies, which in some cases had reached extraordinary proportions. By 1998 they had declined worldwide, but still amounted to nearly $250 billion per year, of which over $80 billion were in the OECD countries and over $160 billion in developing countries (see Table 12.1). These transfers are on broadly the same scale as the average incremental costs of an investment programme required for the world to embark on a substantial policy of climate change mitigation over the next twenty years (see Chapter 9). The IEA estimate that world energy subsidies were still $250 billion in 2005, of which subsidies to oil products amounted to $90 billion[26].

Table 12.1 Energy Subsidies by Source $ billion (data for 1995-1998 period)

	OECD Countries	Countries not in OECD	Total
Coal	30	23	53
Oil	19	33	52
Gas	8	38	46
All fossil fuels	**57**	**94**	**151**
Electricity	-	48	48
Nuclear	16	?	16
Renewables and energy efficiency	9	?	9
Cost of bankruptsy bail-out	0	20	20
Total	**82**	**162**	**244**

Source: de Moor (2001) and van Beers and de Moor (2001). Another perspective on subsidies is provided by Myers, N. and J. Kent (1998) 'Perverse Subsidies: Tax $s Undercutting our Economies and Environment Alike', Winnipeg, IISD.

Applied in the form of tax credits and incentives for innovation, subsidies can and do serve an economic purpose. However, the prevailing subsidies are for the most part not applied to this end. The inefficiencies associated with subsidies have been reviewed by economists many times over the past decades, and can be simply stated:

- subsidies stimulate unnecessary consumption and waste, and more generally are a source of economic inefficiency in that the low price is associated with low benefits on the margin relative to the cost of production;

[26] IEA (in press).

- tend to benefit the middle and higher income groups, so impacting income distribution in a negative way, particularly in developing countries where poor people lack access to energy;
- by undermining the capacity of the industry to earn returns directly on the basis of cost-reflecting prices, subsidies undermine the managerial (or 'X') efficiency of the industry, and also its capacity to finance its expansion;
- lead to wasteful lobbying and rent-seeking by groups trying to maintain or increase subsidies;
- when applied to fossil fuels, subsidies discourage the development of and investment in low carbon alternatives, including investment in carbon capture and storage.

To the extent that climate change policy triggers wider energy reform, it would have great supplementary benefits, as long as the transition is well managed. And for carbon price signals to work well, it is essential that the energy market also works well.

An example of the costs of energy market inefficiencies, and the way in which reforms can deliver environmental and other goals, is given in Box 12.5 for India.

Box 12.5 Fuelling India's growth and development

India's economic growth is constrained by an inadequate power supply that results in frequent blackouts and poor reliability. Subsidised tariffs to residential and agricultural consumers,[27] low investment in transmission and distribution systems, inadequate maintenance, and high levels of distribution losses, theft and uncollected bills place the State Electricity Boards (SEBs, which form the basis of India's power system) under severe financial difficulties.[28] These losses and subsidies are a significant drain on budgets and can result in public spending on vital areas such as health and education being crowded out. Annual power sector losses associated with inefficiencies and theft are estimated at over $5 billion – more than it would cost to support India's primary health care system.[29]

The demand shortages facing India – 56% of Indian households have no electricity supply - create incentives for getting generation plants on line as rapidly as possible. These priorities in turn favour reliable, conventional, coal-fired units.[30] The use of coal for the bulk of electricity generation presents particular challenges. Coal mining is dangerous, and its transportation creates environmental problems of its own. Coal also produces pollutants such as sulphur dioxide that damage local air quality, causing further problems for human health and the environment. These issues are exacerbated by the low energy efficiency of India's coal-fired power plants, combined with India's policies of high import tariffs on high-quality coal and subsidies on low-quality domestic coal. The use of CCS technology will be an important way to reconcile the cost and convenience advantages of coal with environmental goals.

The Government of India has set out an energy policy to help address these constraints and concerns. The broad objective of this policy is to reliably meet the demand for energy services of all sectors at competitive prices, through "safe, clean and convenient forms of energy at the least-cost in a technically efficient, economically viable and environmentally sustainable manner".[31] With sufficient effort made in improving energy efficiency and conservation, for example, the Government of India has stated that it would be possible to reduce the country's energy intensity by up to 25% from current levels.[32] Progress in achieving the goals and objectives of their energy policy, ranging from improving energy efficiency to promoting the

[27] The tariff structure, for example, violates the fundamental principle of economics whereby tariffs should reflect the actual cost of service. In practice, industry is charged the highest tariff despite having the least cost of supply, whilst agriculture has the lowest tariff and the highest cost of service.
[28] World Bank (2001).
[29] World Bank (2006b).
[30] World Bank (2006b).
[31] Government of India (2006: xiii).
[32] Government of India (2006).

use of renewables, will also make a significant contribution to reducing future GHG emissions from India.

12.6 Climate change mitigation and environmental protection

This section looks at the links between climate change and broader environmental protection goals. One area where these links are particularly strong is deforestation. Policies that prevent deforestation can have significant benefits for communities dependant on forests, for water management and biodiversity. Some of these are set out in Box 12.6.

Box 12.6 Co-benefits of ending deforestation

Protection/Preservation of biodiversity: Tropical forests house 70% of the Earth's plants and animals. Without forest conservation, many of the world's plant and animal species face extinction this century. Essential natural resources are found in frontier forests that cannot be recreated.

Research and development: Frontier forests in Brazil, Colombia and Indonesia are home to the greatest plant biodiversity in the world. Destroying these forests destroys the source of essential pharmaceutical ingredients; 40-50% of drugs in the market have an origin in natural products[33], with 42% of the sales of the top 25 selling drugs worldwide either biologicals, natural products, or derived from natural products[34].

Indigenous peoples and sustainability: About 50 million people are believed to be living in tropical forests, with the Amazonian forests home to around 1 million people of 400 different indigenous groups. Forest conservation affects people beyond those who inhabit them. Over 90% of the 1.2 billion people living in extreme poverty depend on forests for some part of their livelihoods[35].

Tourism: Forests provide opportunities for recreation for an increasingly wealthy and urbanised population. Brazil had a five-fold increase in tourists between 1991 and 1999, with 3.5m people visiting Brazil's 150 Conservation Areas.

Consequences for vulnerability to extreme weather events: Forests systems can play an important role in watersheds, and their loss can lead to an increase in flooding. In November 2005 a flash flood occurred in Langkat, Indonesia that killed 103 people with hundreds more missing. The Mount Leuser National Park had lost up to 22% of its forest cover due to logging and, combined with high rainfall, had caused a landslide to occur[36].

In 2004, 3000 people died in Haiti after a tropical storm, while only 18 people across the border in the Dominican Republic died. The difference has been linked to extensive deforestation in Haiti where political turmoil and poverty have lead to the destruction of 98% of original forest cover[37]. Mangrove forests, depleted by 35% (see Millennium Ecosystem Assessment 2005) play an important role in coastal defence, as well as providing important nursery grounds for fish stocks. Areas with healthy mangrove or tree cover were significantly less likely to have experienced major damage in the 2004 tsunami[38].

Reducing GHG emissions from agriculture could also have benefits for local environment and health. For example, in China, nitrous oxide emissions associated with overuse of fertiliser contributes to acid rain, causes severe eutrophication of the China Sea and damage to health

[33] www.fic.nih.gov/programs/research_grants/icbg/index.htm
[34] CBI (2005).
[35] World Bank (2006): 'Forests and Forestry' available from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTARD/EXTFORESTS/0,,menuPK:985797~pagePK:149018~piPK:149093~theSitePK:985785,00.html
[36] Jakarta Post (2003): Rampant deforestation blamed for Langkat flash flood. 05/11/2003.
[37] Secretariat of the Convention on Biological Diversity (2006).
[38] Secretariat of the Convention on Biological Diversity (2006).

through contamination of drinking water. Cutting these emissions could help to reduce these effects[39].

However, climate change mitigation may, if poorly implemented, undermine sustainable development. Chapter 9 discussed the technical potential of biomass to save emissions in the power, transport, industry and buildings sectors. But if the crops are grown at very large scale through intensive, large-scale monoculture, then this has the potential to cause serious environmental impacts. These may include the increased use of pesticides; a loss of biodiversity and natural habitats[40]; and social problems and displacement of indigenous peoples.

Mitigation policies can also sometimes be designed in a way that helps countries cope with existing climate variability and adapt to future climate change. Better design of building stock, for instance, can both reduce the demand for space heating and cooling and provide greater resilience to a changing climate.

While there are important links between mitigation and development, it is important to assess policy development against the full range of opportunities to meet climate goals and the full range of options to achieve the Millennium Development Goals (see Michaelowa 2005). As with other co-benefits, the key is that well designed policy can realise the synergies between different goals, as well as the limits to this. For example, to improve education levels in developing countries, schools could be supplied with low emission energy supplies, or more trained teachers. Both interventions will be associated with a wide range of different costs and benefits, which should be weighed up when considering which option is preferred.

12.7 Conclusion

Whilst climate change presents clear challenges and costs to the global economy, it also presents opportunities. Markets for clean energy technologies are set for a prolonged period of rapid growth, and will be worth hundreds of billions of dollars a year in a few decades' time. Companies and countries should position themselves to take advantage of these growth markets.

It is also important to consider the wider impacts of climate change policy. As well as helping to root out existing inefficiencies, climate change policy can also help to achieve other policies and goals, particularly around energy policy and sustainable development.

A full understanding of these interlinkeages is key to designing policy in a way that minimises the areas of conflict between goals, and to reap the benefits of the opportunities and synergies that exist.

39 Norse (2006).
40 See, for instance, European Environmental Bureau (2006).

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