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Chapter 2

COOL POLICY: CLIMATE CHANGE MITIGATION SUPPORTING GROWTH

Summary

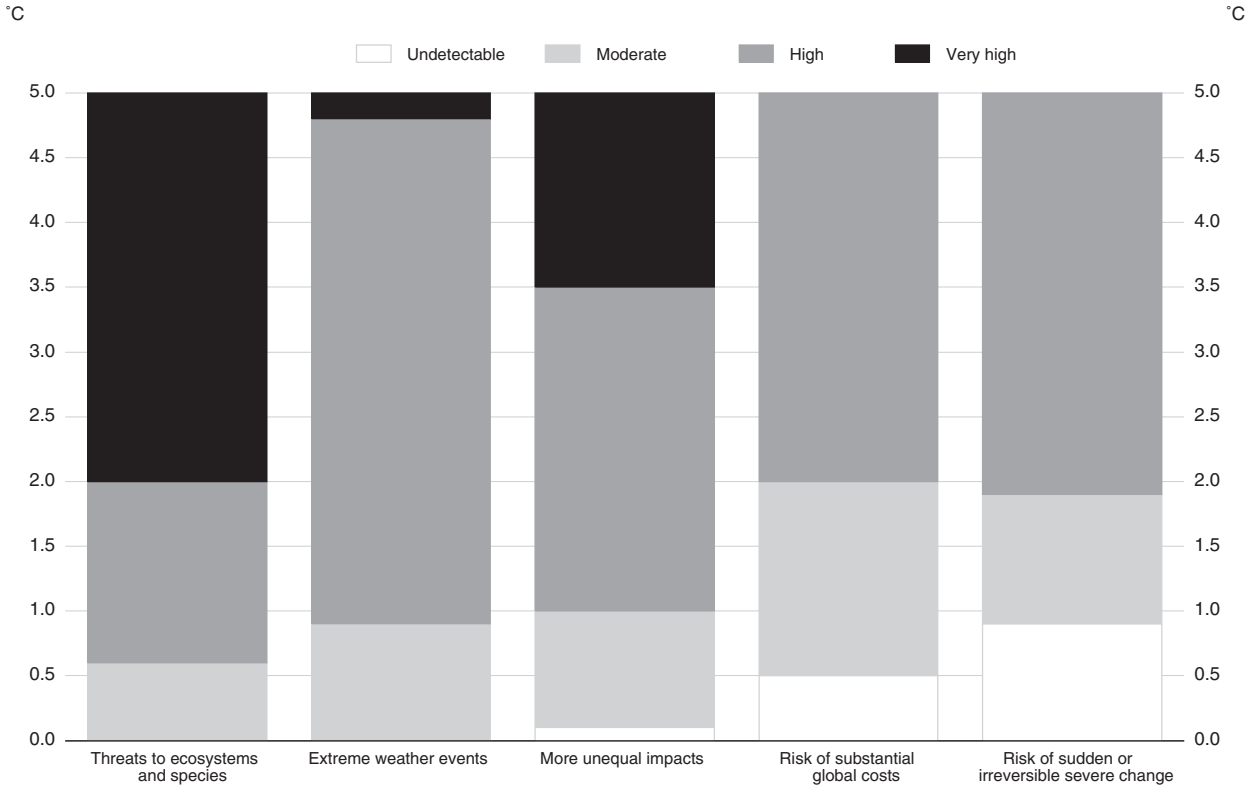
- Climate change must be tackled decisively to avoid future costs, especially to reduce the likelihood of catastrophic changes. Stabilising greenhouse gas concentrations will eventually require a zero net carbon emission economy.
- Markets are beginning to incorporate a number of risks related to climate change. The global public good nature of the climate and the potential consequences of tail risks, nevertheless, call for strong public action to underpin these developments.
- The kind of action that is needed is well-known. Most OECD countries and a growing number of emerging market economies have already taken some action. This has helped to decouple emissions from GDP growth in many countries and led to growing investment in low-carbon technologies. A strong response with decisive and coordinated policies could strengthen the recovery, with a more predictable policy environment boosting investment and research. Both will be needed to meet the challenge of climate change.
- Most policy actions could be budget-neutral and potentially part of needed fiscal reform. Worries about the effect on the poor can be dealt with within such reforms. Some policies, including for green investment, are pro-growth. Hence, concerns related to fiscal balance, inequality or growth should not be used as an excuse to delay policy action on climate change.
- There are plenty of examples of countries and regions that have taken individual actions successfully (including Indonesia, Sweden and British Columbia) without obvious negative consequences for equity, fiscal balances, investment or productivity.
- Some carbon-mitigation measures that have been excessively expensive, such as very high feed-in tariffs, are being reined back, and the lessons from them should be incorporated into future policy design.
- There is room for experimentation, but policy makers should in general avoid measures that favour particular industries, energy sources or technologies, and instead seek to install consistent incentives to reduce emissions and to encourage research and investment in new technologies, across the whole economy.

Introduction

The 21st meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change, COP21, is concerned with securing our long-term future. On current trends and policies, greenhouse gas emissions over the next 50 years will cause damaging changes in the world's climate. This is true especially, but not only, in some of the poorer and emerging market economies. Furthermore, the climate system is sensitive to, and subject to, threshold effects; the potential for very rapid changes - whose effects may not be manageable, even catastrophic - will increase significantly if temperatures rise too far (Figure 2.1). To keep these risks down, ambitious reductions in greenhouse gas

Figure 2.1. **Level of additional risk due to climate change**

Global mean temperature change,relative to 1986–2005



Source: Adapted from Figure 1, Box 2.4 in IPCC(2014c), 5th Annual Synthesis Report.

(GHG) emissions are required, more ambitious than embodied in this year's independent nationally determined commitments (INDC), along with the decisive policy actions needed to achieve those reductions (IEA, 2015a). To have a chance of keeping climate change within acceptable limits, the world will have to move to zero net carbon emissions before the end of the century (IPCC, 2014a).

Set against the fragility of the short-term macroeconomic situation in many countries, this long-term concern might seem less urgent. Costly action on climate change may be thought to add to the short-term economic problems. On the contrary, however, a credible plan of action to reduce emissions over the longer term, including firm measures to change the path of emissions in the near future, can complement measures taken to promote economic recovery. Studies suggest that, once economies adjust to new policies, the cost in terms of lower material living standards is quite low. Nevertheless, there are adjustment costs, likely concentrated in particular kinds of activity and therefore felt more strongly in some countries than others. To allow these adjustments to be made as smoothly as possible, early and progressive but decisive action is needed. The range of actions needed (Box 2.1) has been broadly understood for some time. Many of them can be part of policies introduced to spur short-term growth and improve longer-term prospects, such as tax reform, public investment programmes, or action on research and development. Moreover, over the last few years, oil market volatility has led to large and rapid changes in final user

Box 2.1. **What's needed: Key policy measures to reduce greenhouse gas emissions**

Pricing greenhouse gases

- Phase in effective prices on emissions of carbon dioxide and other significant greenhouse gases, including through abolishing fossil fuel subsidies.
- Prices for different gases and sectors should converge through time on a uniform CO_2 equivalent price.
- The price should apply in public policy decisions as well as for private transactions.
- It can guide policy even in areas where direct emission pricing is impossible, such as deforestation and agriculture.

Regulation

To back up greenhouse gas (GHG) pricing, regulatory measures can be necessary, such as:

- emissions regulation where explicit pricing is infeasible;
- 'nudging' policies to influence consumer or producer behaviour where information gaps, myopia or habits and inertia inhibit reactions to pricing; and,
- incentives to invest where financial market myopia, long time horizons, or policy uncertainty lead to market failure.

Research and development

- Increase public funding for R&D aimed at reducing GHG emissions and encourage private sector R&D in the same direction.
- Promote technology transfer so that effective mitigation techniques are disseminated as rapidly as possible.

Public sector planning

- Public policies and investment decisions that have long-lasting impacts on technology choices or economic structure, such as urban planning and energy infrastructure, should be assessed on their costs and benefits, with their impact on GHG emissions through time valued at the price expected for private transactions.

Aligning policies

- Climate policy can be made more effective if ministries with portfolios outside the traditional climate agenda can revisit the most misaligned policy frameworks in their domains.
- There are no universal solutions to misalignments, as policy setting technology choices, technology priorities, development priorities and resource endowments vary across countries. But every county can make a diagnosis by taking a comprehensive look at policy settings, and start addressing misalignments with climate goals for a more sustainable, low-carbon future.

prices of petroleum products. Economies have generally adapted to these changes, which are larger than carbon pricing itself would generate in the near future.[1]

This chapter gives a brief overview of the gains from taking action now to limit climate change, emphasising that an extremely important – but difficult to value - part of those gains comes from reducing the risk of catastrophic scenarios. The chapter acknowledges that there are definite economic costs involved – as with any policy reform – but that these are small relative to consequences of such tail events. Next, the chapter notes that some progress has already been made towards the climate change goal, even with somewhat

1. For example, the additional gasoline tax due to adding a tax of USD 50 per ton of CO_2 to existing taxation would be about 44 US cents per gallon, or 11 US cents per litre.

inconsistent policy signals so far. Finally the chapter argues that, far from impeding the current fragile recovery, ambitious measures to set the global economy on a path to zero net greenhouse gas emissions can fit very well within current policy priorities of stimulating investment and technical progress, tax reforms and environmental improvements. These measures need to be part of clear and credible policies, so that individuals and firms fully understand the need for change and plan current and future investment in line with climate change objectives. Addressing climate change policies now and in this way will more likely support than derail global economic growth.

Why act? What's the problem with global warming?

Years of research have established that increased GHG emissions as a result of human activity have led to and, if nothing is done, will continue to lead to significant increases in global average temperatures. Although there is some uncertainty about the exact response of average temperature to GHG concentrations, the Intergovernmental Panel on Climate Change (IPCC) estimates that current trends will lead to an average temperature rise somewhere between 3 and 5°C.

To put this in perspective: "When global warming has happened at various times in the past two million years, it has taken the planet about 5,000 years to warm 5 degrees. The predicted rate of warming for the next century is at least 20 times faster. This rate of change is extremely unusual" (NASA, 2015). This rapid increase will make it difficult, and in some cases impossible, for ecosystems and societies to adapt. Moreover, rapid and irreversible changes, with catastrophic consequences, in at least some regions, seem likely (IPCC, 2014b). Rises in sea levels of several metres due to melting of one or more of the major ice sheets, or disruption to ocean currents that could cause rapid switches in regional climates, are examples of these changes. Natural global climate change at rates lower than current human-related climate change "caused significant ecosystem shifts and species extinctions during the past millions of years" (IPCC, 2014b). Current world tensions over migration, water, land and other natural resources illustrate limits to the ability of human societies to easily adjust.

Climate change will reduce overall disposable incomes partly through some direct effects on productivity in food production, partly through the effects of losses of land through sea-level rise or through increased recurring damage from extreme weather events. These are partly offset by some expected benefits from higher temperatures in some areas and the higher CO_2 concentrations that can favour plant growth.

Recent OECD modelling work shows that the net economic consequences are projected to be negative in 23 of 25 world regions (OECD, 2015c). They are especially large in Africa and Asia, where the regional economies are vulnerable to a range of different climate impacts, such as heat stress and crop yield losses. Variation within some regions is likely to be higher than variation across regions. The two regions estimated to benefit from climate change are those with significant territory in the higher latitudes.

Some of the social costs of change would be those associated with changes in production and losses of productivity. Probably more significant would be difficult-to-quantify costs from premature death and the social costs of migration and other adaptive behaviour that cannot be captured in GDP. It is the substantially increased risk of catastrophic changes, especially if rising temperatures trigger some of the potential climate tipping points, that calls for action.

Action is needed

Adaptation

Some climate change is already inevitable, so we will need to adapt. Much adaptation will take place without any policy action as people and firms adjust to changing circumstances. But it is important to plan for policies to facilitate adaptation, especially where long-lasting investment in public or private infrastructure is concerned. Many countries already have such policy frameworks in place, for example planning construction codes to anticipate sea level rise. There are many other steps that can be taken, such as anticipating the zoning and infrastructure policies that will be needed to moderate the impact of flooding caused by more frequent and severe heavy precipitation events (OECD, 2015e). In many cases, the impact of climate change will be to accentuate existing problems, such as migration flows, rather than to create new ones, so it is not easy to blame any particular phenomenon on our own carelessness with the atmosphere.

The magnitude of likely global temperature change if growth in GHG emissions is left unchecked, and the disproportionate increase in the risk of catastrophic changes as temperatures rise beyond the hoped-for limit of a 2° C increase relative to pre-industrial levels, mean that action to reduce emissions is necessary. For example, with larger increases in temperatures, migration flows clearly caused by land being swallowed by sea-level rise will be added to those with poverty or conflict as proximate causes. Relying on adaptation is not enough.

Action has been piecemeal

This conclusion was reached nearly two decades ago and the necessary policies are summarised in Box 2.1 and have been set out in more detail in many places (OECD, 2009, 2015a; IEA, 2015b). Those policies are required to achieve three broad objectives: (i) to discourage activity that emits GHGs; (ii) to encourage investment in technologies that support low-emissions activity; and (iii) to encourage research to generate new technologies. In general there has been progress, but apart from being insufficient, it has left doubt about whether governments are fully committed to a credible and coherent set of policies to address the twin tragedies of the commons and the horizons that are at the root of the climate change challenge (Box 2.2).

Central to all these objectives is to ensure that emitters of CO_2 and other GHGs face a clear incentive to reduce emissions, by establishing a carbon price. The idea of a carbon price is more than ensuring that actual transactions take into account their impact on climate change. It is also needed for *ex ante* public investment and policy evaluation, as a "shadow price" in cost-benefit investigations.[2] In 1997, the Kyoto Protocol was designed as one way to work towards such a price. This prototype for a worldwide "cap-and-trade" system for GHG emissions presupposed a strong degree of common purpose which could have expanded to a worldwide level. Such an expansion was not part of the objective at that time, and the parties to the protocol were differentiated into two groups, one of developed countries who took on explicit emission reduction objectives and the others who did not. Despite the advantages of the cap and trade approach (Box 2.3), the Kyoto Protocol was not ratified by some key countries, though it came into force in 2005 for those who did ratify.

2. Smith and Braathen (2015) surveys the current use of carbon pricing across the world.

Box 2.2. **Two tragedies**

Resources can be severely over-exploited, when benefits from their use accrue to individuals or small groups but the costs are widely shared. Private benefits can exceed private costs even up to the point where the resource is destroyed entirely. This **Tragedy of the commons** applies in the case of greenhouse gas emissions, where the corresponding resource is the ability of the atmosphere to absorb emissions without causing global warming.

A related misuse of resources can occur when the benefits of use are felt in the present but the costs arise in the distant future, incurred by generations who have no voice in today's decisions and when most of the beneficiaries are likely to have died. As the effects of GHG emissions are felt over several generations, the **Tragedy of the horizons** is also a key characteristic of climate change.

Decisions that are efficient for society as a whole in this kind of context depend on a high degree of coordination and consensus. Box 2.3 suggests one natural, if idealistic, approach to the tragedy of the commons. Standard economic methods of discounting future costs and benefits may be inappropriate in the case of the very distant time periods implicated in climate change (Heal, 2009) reviews the issues on discounting), while the prospects of tail events are difficult to price in any case. Both of these accentuate the tragedy of the horizons.

In many transactions, an implicit carbon tax is already in place. The highest taxes are due to the taxation of energy, especially transport fuel; those taxes mostly pre-date concern about climate change. Expressed in terms of CO_2 content, the taxes vary widely across and between countries. In Germany, for example, which has a strong programme to switch to green energy, the highest tax rates can be ten times higher than the lowest, while some fuels are not taxed at all. A similar pattern can be seen everywhere, even when the different rates are averaged across countries (Figure 2.2). There are different external costs for different uses of fuels, so there can reasonably be some difference in taxes when expressed only in relation to carbon content. But the degree of variation observed is more than can be justified in that way; it gives distorted incentives. A more efficient tax structure would level out the tax rates, as would a carbon trading system applied uniformly to all emitters. The other main greenhouse gases, methane and nitrous oxide, are not subject to direct pricing in any country because specific emissions are hard to monitor and measure.

Many other kinds of policy are in use. An overview can be found in OECD (2015b). These include regulations on building standards, waste disposal, fertiliser use, fuel economy or energy efficiency, tax incentives or subsidies for energy efficient appliances or vehicles, or public procurement policies. Some of these policies are only second best, being relatively inefficient compared with a carbon pricing mechanism, although they may have other objectives than reducing GHG emissions; fuel economy standards and certain subsidy programmes are examples (Parry et al., 2014; Fowlie et al., 2015; Ito, 2015). In other cases, they are necessary either to back up carbon pricing, or to cover market failures where information asymmetries or other barriers inhibit behavioural reaction to pricing, or where monitoring is too costly. Conversely, they are unlikely to work well where carbon pricing at adequate levels is not in place.

On its own carbon pricing can have significant effects. This can be seen reflected in the relatively low fuel consumption of vehicles using highly-taxed road fuel in Europe compared with the United States, and in the significant cut in fuel consumption in British Columbia after that province introduced its own carbon tax independently of the rest of Canada (Figure 2.3). Some research suggests that the response in British Columbia was

Box 2.3. **A worldwide cap-and-trade system? Seemingly impracticable, but useful as a reference point for other options**

The Paris meeting of the Conference of the Parties to the UNFCCC is focusing on a set of independently determined national targets for reducing greenhouse gas emissions, recognising that there was little chance of agreeing on a comprehensive global agreement such as the cap-and-trade agreements that are in operation in some regions. Cap-and-trade, as a voluntary action by a group of countries, has some valuable attributes which are nevertheless worth recalling.

The atmosphere is a global resource which no individual can appropriate for their private use, nor protect against abuse by others. It, and the services it provides, are therefore subject to the full consequences of the "tragedy of the commons" (Box 2.2).

One way to reduce the risk of over-exploitation represented by the tragedy of the commons is to assess a sustainable rate of exploitation and attribute property rights in such exploitation to individuals. This approach is already widely used (often with imperfections, largely due to enforcement difficulties), for example in contexts such as protecting fisheries or limiting water use. As the climate-regulation property of the atmosphere is a true global resource from which everyone benefits equally,[1] a natural inclusive approach would give equal emission rights to everyone, more practically to each country in proportion to its changing population. In principle the sum of those rights over time would be equivalent to the carbon budget, the limit on accumulated GHG emissions that is consistent with stabilising atmospheric concentration at a tolerable level. IPCC estimates are that the carbon budget needed to limit the temperature rise to within 2°C would be used, at current emission rates, within 25 years.

An effective market in such emission rights would allow emission-intensive activities to occur where they were most valuable, at the same time compensating others for use of "their" rights. Currently, the issue of financing climate change policy, and the necessary investment and adaptation, especially in developing countries, is a difficult part of the climate change negotiation process.

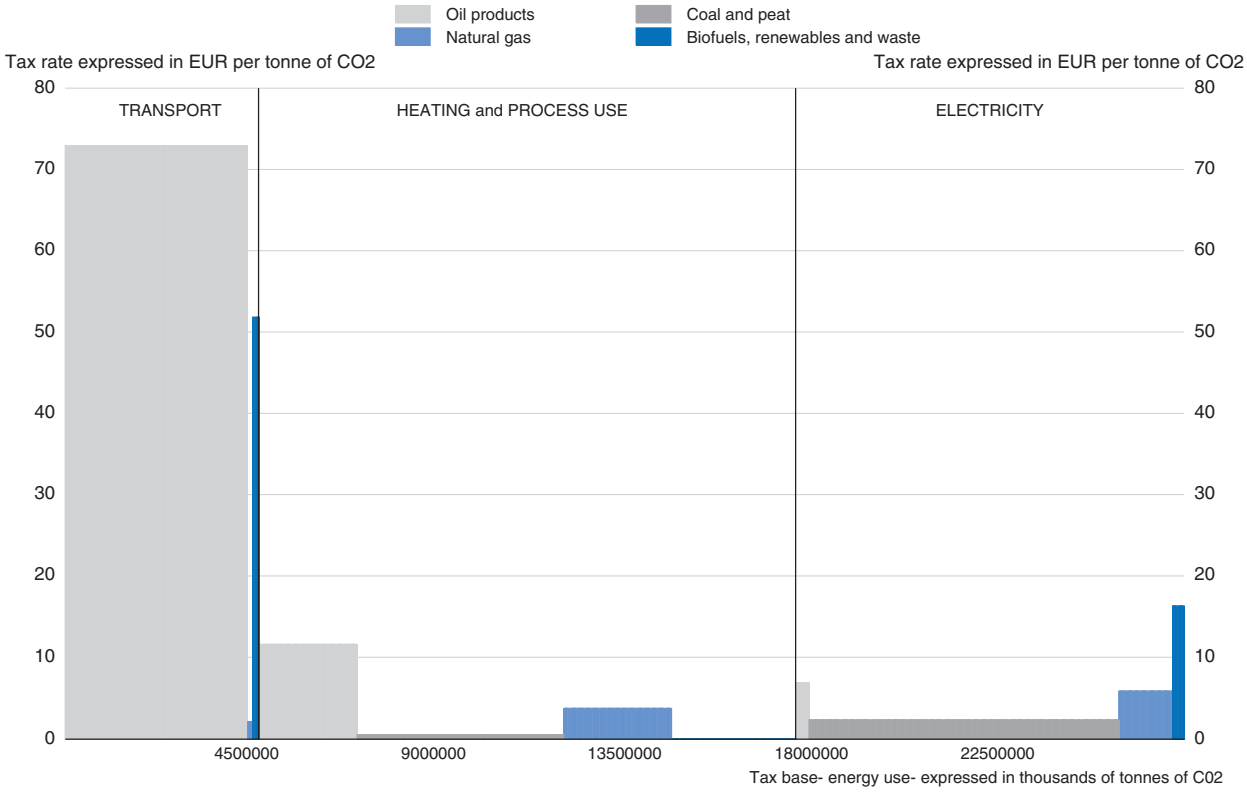
Carbon prices would emerge naturally from this trading and, if the market were reasonably efficient, prices would converge to be the same in all countries. Established emission-intensive interests would lose substantially from such an approach, as they would from any measure of effective GHG emission pricing, while some current low emitters would benefit.

Other methods of establishing a GHG price, such as carbon taxation, have many properties in common with a worldwide cap-and-trade system. Explicit taxes can provide a clearer, more immediate, price signal than the uncertain outcome of trading systems. For example, the allowance price in the European Trading System has been very low as a result of poor initial implementation, the severe recession and perhaps also uncertainty as to the future of the system. The greater certainty of other pricing mechanisms can be partly illusory, however, as tax rates are likely to need adjusting as experience reveals how the economy reacts. Related market incentives, such as feed-in tariffs for different types of renewables used in electricity generation, have been very unstable. Furthermore, they do not lead so easily to a common carbon or GHG price, nor to a redistributive mechanism with such a natural justification.

Such a cap-and-trade system is simple to outline, but enormously difficult to negotiate or implement, because of differences of view and economic interests between and within countries and because of the costs of monitoring and enforcement. Though an implausible outcome in the short term, it could be thought of as a reference point for the evolving diverse set of targets and policies used in different countries.

1. This is not strictly true since some, hard to identify, people are likely to benefit from climate change.

Figure 2.2. **The carbon tax[1] in OECD and seven partner countries [2]**

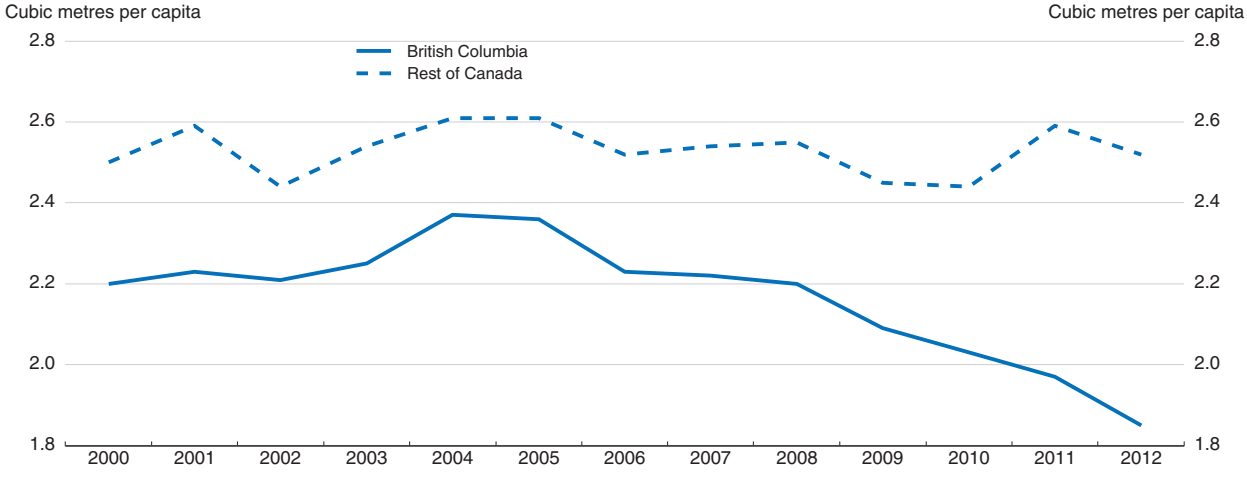


1. Calculated as total indirect taxes on each fuel-use divided by implicit CO_2 emissions from combustion. It therefore includes taxes whose purpose is not carbon taxation per se.
2. Argentina, Brazil, China, India, Indonesia, Russia and South Africa.

Source: OECD (2015), Taxing Energy Use 2015.

StatLink http://dx.doi.org/10.1787/888933296597

Figure 2.3. **Sales of petroleum fuels subject to British Columbia's carbon tax**



Note: Years N start in August N-1 and finish in July N.

Source: Statistics Canada (2015), CANSIM database.

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stronger than might have been expected on the basis of the actual change in tax-inclusive fuel prices, partly due to the visibility of the carbon tax (Rivers and Schaufele, 2015).

Finally, while continuing GHG emissions could lead to changes in climate quite outside previous experience, putting a price on CO_2 and other emissions, even a quite high and rising price, would not be so unfamiliar. Swings in the price of oil have been at least large, if not greater, than likely carbon taxes. Oil price changes involve shifts of income between countries rather than the largely domestic switches that carbon pricing involves. Yet the world economy has learnt to deal with these changes successfully.

Financial markets and climate change

Getting the price right should encourage both investment in, and the development of, low-carbon technologies - provided finance is available. But the same kind of difficulties faced by R&D – the long time-horizons involved, dependence on future government policy – can inhibit the availability of private sector finance. For example, the financial community may be more sceptical about governments' long-term commitments to support than entrepreneurs. The mobilisation of finance to help poorer countries reduce their emissions and deal with the consequences of climate change is one of the key sticking points in climate change negotiations. Progress in meeting existing financial commitments by developed countries is hard to monitor or assess (Ellis and Moarif, 2015).

Innovation in financial instruments may improve access to private sector finance for climate change activities. For example, "project bonds" have been developed as a means to introduce private finance into infrastructure projects, even when the ultimate sponsor is the public sector, though a major part of their attraction is the tax concessions they are often given. Applying a similar model to climate change initiatives could widen the range of finance available for climate change projects. A market for "green bonds", characterised by being tied to specific projects such as renewable energy, is developing. Annual issuance of "labelled" green bonds was USD 10 billion in 2013, rising to USD 18 billion in 2014.[3] Though green bonds might remain a niche market driven by some investors' preferences for such investments, unless either the investments or the bonds themselves are subsidised, there is potential for growth: in 2015 institutions such as Barclays, Deutsche Bank and Citigroup announced major investments in green bonds to be held as "high-quality liquidity reserves", and the German government announced its intention to purchase EUR 1 billion of green bonds through the country's KfW Group development bank, while in 2011 total outstanding green bonds represented under 0.02% of capital held in global bond markets (Bloomberg, 2015a, 2015b; Della Croce et al, 2011). In a period when central banks are active in promoting recovery from the financial crisis and recession by supporting financial markets, providing this support to suitable instruments financing GHG mitigation, "green monetary policy", could constitute a useful extension.

Financial markets are also important for the capacity of the insurance and reinsurance industries to provide cover to help manage extreme events. OECD (2015g) notes the development of "catastrophe bonds", where payout is often triggered by specific events rather than on the basis of quantified damage, as an element of innovation in financial markets that can improve the supply of funds to insurance markets. There may be a role for governments in ensuring that disaster risk coverage is available in the insurance and

3. See Climate Bonds Initiative, *https://www.climatebonds.net/cbi/pub/data/bonds*.

reinsurance markets. Where the scope of such uninsurable risks is limited, this has often been addressed through targeted investments in risk reduction. For example, in Australia, a range of specific mitigation investments have been made by the government to reduce the potential for loss in areas severely affected by the 2010-11 Queensland floods. In Germany, a programme has been established to allow households in flood-exposed areas to obtain a flood-resilience certificate, based on an assessment by authorised experts, as a means to secure insurance coverage. However, intervention in the provision of disaster insurance must be carefully designed to ensure that government involvement does not discourage the development of private markets for disaster insurance (see OECD, 2015g).

These and other financial innovations could help both to accelerate progress in cutting emissions and to improve the ability of the economy to manage risk through insurance, while also mobilising idle funds. Once financial markets are fully convinced that governments are serious about climate change policy and using market mechanisms like carbon pricing with well-defined time profiles,[4] private finance for research and investment will in any case be more readily forthcoming. This, together with continued financial innovation, could magnify any macroeconomic stimulus from climate change policies by helping to accelerating the investment response.

To some extent, this finance will be switched from projects that carbon pricing or regulation have made unprofitable. There are potential risks for the short-term here, as financial markets identify companies who may be left with "stranded assets" – investments that seemed profitable when they were made before public policy on climate change was clear. Bank of England (2015) notes this as a potential – but manageable – risk for insurance companies' asset management operations, in addition to their potential liabilities on insurance itself. The insurance industry is one key part of the financial sector which may promote action in its own interest.

Insurance: coping with climate change – and reducing it?

Since the "climate" can only be described statistically rather than with certainty, climate change can be difficult to spot. But one of the main characteristics of predicted change is increased frequency of extreme events, where insured damages can be very large. IPCC (2012) provides evidence of a number of likely impacts of climate change on the nature of extreme events, such as more heavy precipitation events and a shift in extra-tropical storm tracks towards the poles. There is some evidence that these impacts are already being felt, in that hotter temperatures and drought may be increasing the frequency and size of wildfires in the United States (Dennison et al, 2014); the intensity of tornadoes may increase as a result climate change (Elsner, Elsner and Jagger, 2014). The number of registered weather-related natural hazard loss events has tripled since the 1980s (Bank of England, 2015, reporting data supplied by Munich Re). There does seem to have been some rise, though very erratic, in economic losses from natural disasters over the past few decades. Inflation-adjusted insurance losses from weather-related natural hazard losses have increased from an annual average of around USD 10 billion in the 1980s to around US$50 billion over the past decade (Figure 2.4), even if the total remains small

4. For example, a recent French law sets a carbon tax at €14 per tonne, and announced that the level of the tax will rise to €56 by 2020 and €100 by 2030. Most countries have in the past had special arrangements on energy taxes for particular sectors (reflected in Figure 2.2); governments will have to show that this will not recur if they are to generate full credibility for this sort of measure.

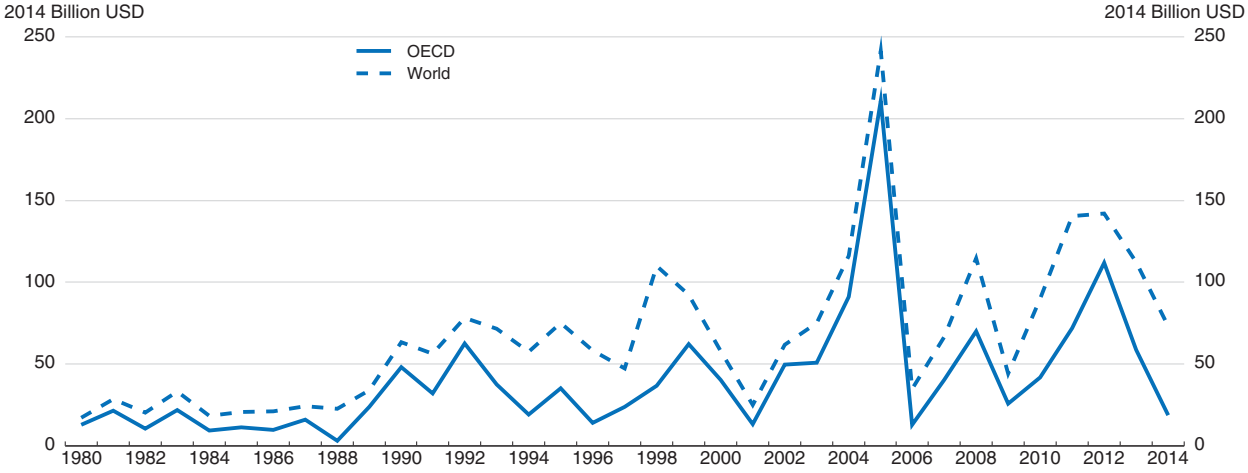
compared with global wealth.

Climate change cannot be confidently identified as a factor in this increase in insured losses, because many other contributory factors are at work, including wider insurance cover, the increasing value of insured assets as the economy grows, or greater activity in risky areas. Increased economic integration, facilitated by transport mobility and communication, has also acted as a vector for propagating shocks globally (OECD, 2014). Climate change is nevertheless predicted to increase some types of insured losses. The insurance industry is thus in a good position to detect change and may be able to price in the costs of climate change, creating incentives for both adaptation to, and avoidance of, climate change.

One kind of risk insurers could face gives them a direct interest in avoiding climate change. They could potentially in the future face liability claims similar to those related to asbestos, on the grounds that the companies they had insured had been negligent in emitting greenhouse gases and thereby causing climate change, increasing the probability of weather-related damage (see e.g. Faure and Nollkaemper (2007); Ross et al (2007); Faure and Peters (2011)). Though it is not clear that such litigation would be successful in making insurers liable for damages, the possibility that it might be reinforces the incentive for insurers to find ways to encourage GHG mitigation. The insurance sector has generally been quite vocal in supporting strong action against climate change (see e.g. *http://www.climate-insurance.org*). Insurers are also likely to face higher payouts through time in any case; for example, climate-related supply chain disruption is already an issue for them (Advisen, 2013). Bank of England (2015) surveys climate change issues in insurance from the regulator's point of view.

Insurance policies usually carry clauses to reduce the risk of accident by invalidating claims, or provide for "deductibles" (reduced compensation) if the policyholder has not taken obvious precautions (specified in the contract). Such clauses work best when the underlying risks are stable. Where the underlying risks are changing, but to an unknown degree, insurance companies, always exposed to normal "tail" risk, can be exposed to a

Figure 2.4. **Economic losses from climatological, meteorological and hydrological disasters**



Source: OECD (2015e), Climate Change Risks and Adaptation: Linking Policy and Economics.

StatLink http://dx.doi.org/10.1787/888933296615

different kind of risk, that of predicting the underlying likelihood of damaging events. When this is too difficult, the private sector may withdraw from providing insurance (Bank of England, 2015). This may be felt as "unfair" though ironically it is good for adaptation: the absence of flood insurance is a strong incentive to avoid building on flood plains. On the other hand, private insurers will generally not handle the risks of nuclear accidents, which are usually taken up by the public sector.

Although the role of insurance in adaptation can thus be important (OECD, 2015e), insurance can theoretically generate "moral hazard" where the fact of being insured results in people or companies being less vigilant in avoiding risky behaviour. Flood insurance, either private or through public insurance, could have combined with insufficient land-use controls to increase losses due to catastrophic floods in a number of countries in recent years, for example. The use of deductibles can both reduce this risk and give incentives to take action, however. Flood Re, a UK public insurance scheme to which every citizen has to contribute (through household insurance), replacing private insurance, limits this by excluding coverage of houses that were built after 2009 on flood plains. The US National Flood Insurance Program similarly limits the availability of insurance to communities that commit to adopting and enforcing floodplain management regulations.

The design of insurance policies can have a positive role to play, although the insurance industry itself may be less dependent on clear and credible climate change policies than other industries, since its existence is due to uncertainty itself. The actual occurrence of individual catastrophic events does not necessarily lead to lower overall supply of insurance. For example. Kramer and Schich (2008) show that following the 20 most costly disasters between 1974 and 2004, where insurance companies saw very large payouts way beyond accumulated premiums, insurance companies' share prices tended to rise relative to the market after an initial fall. Disasters appear to stimulate the demand for insurance, allowing insurers to charge higher premiums, making more profit and attracting new capital.

But industrial and commercial companies' insurance risks depend in part on regulatory policy, such as rules on flood plain building or on liability for contributions to climate change, for example. Appropriate and credible regulations in such areas can help to prevent a narrowing of insurance cover and increases in premiums in the face of global warming, so that the insurance sector can improve economies' resilience both by promoting adaptation and by sharing catastrophic losses.

Greenhouse gas mitigation and the short-term outlook

Slow and piecemeal action is costly, not only due to the reduced chances of avoiding climate change, but also because it can affect macroeconomic prospects, particularly when the outlook is fragile as it is now. Clear commitment now to strong GHG mitigation emission policy over the next decade could actually boost the economy in the short term, even though the objective of GHG policy itself is to change the structure of economies rather than their overall growth rates. Some effects could be directly related to the policies themselves, others more indirectly through links with confidence and expectations.

Reducing greenhouse gas emissions with investment

Investment is key to preventing climate change in the longer term as well as to reviving economic growth in the short to medium term. The switch to low-emission power

generation will need investment in technologies which are more capital intensive than fossil-fuel-based generation, and other measures such as improved building standards also call for more investment spending. Investment can be costly, but in current circumstances, with many economies operating well below capacity and with an overall shortfall in investment (OECD, 2015d), an additional benefit from a reinvigorated long-term investment strategy would be its contribution to stimulating demand and supporting the recovery into the medium term. Its magnitude depends on the nature and timing of the needed investment as well on the extent to which it represents additional investment, as opposed to investment in new technology being offset by declining investment in GHG-intensive technologies.

As far as public investment is concerned, projects should be subject to normal evaluation procedures focusing on value for money, where a high – and rising through time – shadow price of GHG emissions is part of the analysis.[5] GHG emission-reduction policies or projects cannot be valued entirely "normally" however, because there is little empirical basis on which to evaluate the costs of tail risks.[6] The demand channel would vary by country but could be both in investment and exports, as many countries would need to import technology and equipment from OECD (and non-OECD) suppliers.

In the longer run, successful climate change policy could also support even those economies that might be less affected by climate change damage, as it will improve prospects in many developing countries which are both highly vulnerable to climate change and likely to be of growing importance as trade partners for OECD countries. As investors respond not just to today's developments but also to long-term prospects, removing possible climate change catastrophe as a source of future concern may raise confidence even in the short run.

That said, estimates suggest that even quite determined climate change policies seem unlikely to elicit demand for investment that is extremely large in aggregate macroeconomic terms. The required shifts in the composition of investment may be substantial, nevertheless, and the sooner that policy makers are committed to this, the better. IPCC (2014c) estimates, with a wide margin of error, that the net rise in investment needed to respond to climate change policy could be $500 billion annually, with the increase in "green" investment being partly offset by less investment in, for example, coal-fired power generation. This is about 5% of total fixed investment in OECD countries, or 2½ per cent of fixed investment globally, in 2014. Corfee and Kennedy (2013) also conclude, again with a wide margin of error, that the net increase in investment could be up to $450 billion a year. From a different perspective, IEA (2015b) has estimated that, up to 2030, the level of investment in energy efficiency, the power industry and fuel supply will average more than 10% of total investment in OECD countries, but that the total would not rise substantially even on the path needed to keep atmospheric GHG concentration within the limit of 450 parts per million and thereby limit the likely temperature rise to 2° C.

5. The long period of low long-term interest rates is leading a number of countries to consider revising down the inter-temporal discount rate used in investment and policy evaluation. A lower discount rate increases the importance of future monetary benefits and costs compared with today's.
6. This is because of multiple uncertainty and lack of information. The impact of any policy on actual GHG concentrations is uncertain. The conditional distribution of the risks of climate change for any given change in concentrations is unknown, especially concerning the catastrophic or "tipping point" events. The consequences of those events on future economies are, in turn, also uncertain.

Research and development

Research and development spending on low carbon energy sources and on energy efficiency is essential to developing new technologies on which a low-carbon future depends. Among the OECD member countries for which statistics are available, total expenditure on energy-related research, development and demonstration (RD&D) accounts for between 0.001% (Portugal in 2013) and 0.167% (Luxembourg in 2012) of national GDP, with the simple average around 0.045%. Much of this goes on either energy efficiency or renewables, although in some countries nuclear power or fossil fuels take a significant share (a high share for fossil fuels is usually due to carbon capture and storage research). The overall amounts are relatively small, on average total public spending on energy-related RD&D amounts to only around one fifth of the average revenue from environmental taxation.

Public support for RD&D is important, because it can be a public good with a number of market failures in its production (for a comprehensive discussion, see Andrews and Criscuolo, 2013). The degree of market failure can justify more durable policies than the "nudges" that are sufficient elsewhere, especially because of the long time-horizons involved in developing new technologies to avoid climate change. Policy instability itself is also an obstacle, just as for fixed investment decisions.

Design of RD&D support is difficult. For example, a key choice is between "picking winners" with targeted support, where misguided administrative decisions can be very costly, and general support through tax allowances or subsidies, which run the risk of financing activity that would have happened anyway. Which is more cost-effective is not clear. Broadly, public financing is best for basic research and general purpose technologies with broad applications, such as energy storage.

Successful RD&D and innovation policy can be very important, especially where it can support fairly broad objectives; support directed at climate change policy can have spillovers for other industries. In this way, just as fixed investment encouraged by climate change policy may improve short-term prospects from the demand side, increased overall expenditure on RD&D, even if primarily directed towards specific climate change issues, could well improve longer-term prospects for overall productivity growth. Both spillover effects and stimulus to the supply of RD&D facilities and researchers themselves may play a part in this long-run effect.

Investors need clear signals

Policy instability can be a source of uncertainty for investors and researchers. Investors' lives are already full of uncertainty, and those related to new technologies and long-lived equipment, as is overwhelmingly the case in climate change, are particularly difficult. Where possible, policy makers should therefore avoid adding to this uncertainty. Governments cannot directly reduce the inherent uncertainty in climate change itself, although they can use measures such as subsidies or guaranteed prices to shift the risk away from investors.

Successful climate change policy will reduce the overall level of risk, however, because by reducing the rate of global warming it makes the catastrophic outcomes, whose consequences are particularly difficult to deal with, less likely. High levels of overall risk are likely to depress investment, as firms may prefer to wait rather than make difficult-to-reverse decisions. Some work also shows that higher levels of uncertainty reduce the

responsiveness of investment to shocks (Bloom et al, 2007). This might affect the ability of policy to get investment moving again after recessions, for example.

Policy instability is itself a source of uncertainty for investors and innovators. This is a particular problem for climate change policy, because of the very long-term horizon and the relatively short history of policy engagement on the issue. Climate change policy has indeed suffered from instability in some countries. For example, carbon taxes have been proposed and then removed or watered down (France, Australia), trading systems have been poorly implemented (EU ETS), subsidies to renewables have been at first excessive and then radically reduced in many European countries or have had their conditions frequently modified (Italy, United States).

Policy makers must therefore tread a line between providing long-term assurance that investments made today and today's research and development activity will be profitable many years hence, and preserving the flexibility needed to adjust policies in the light of experience and changing circumstances. Hence, clear and credible policy frameworks can reduce long-term climate risk and shorter-term policy risk, further enhancing the prospects for investment growth. Where credibility is low because of past instability, it cannot be rebuilt rapidly or by ambitious statements of intent alone and there are no clear commitment mechanisms. Policy statements coming from COP21 therefore need to be ambitious, but with a credible level of ambition, and subsequently backed up by steady introduction of the right policy measures. One way to promote such clarity is to ensure that different kinds of policy are consistently directed towards the policy objective (Box 2.4). The sooner this is done, the stronger will be the investment response.

Environmental stringency, productivity growth, and competition

Clear and credible commitment to GHG mitigation means more stringent policies. OECD research suggests that, despite claims, there is little evidence of adverse effects of more stringent environmental policies on short-term productivity growth (Albrizio *et al*. 2014). This result does need to be treated with caution – there are losers and winners. Productivity gains can come from axing less efficient and/or more polluting activities and one possible consequence is industry shutdowns or "leakage" to other countries. Follow-up research (Kozluk and Timiliotis, 2015) suggests that leakage is rather limited, and its impact on the trade balance should be eventually offset by the improved comparative advantage of "cleaner" activity. In the short term there may nevertheless be some adjustment costs. The already low risk of leakage is much reduced if stringency can be increased simultaneously in many countries, as can hopefully be achieved in the current climate change negotiations.

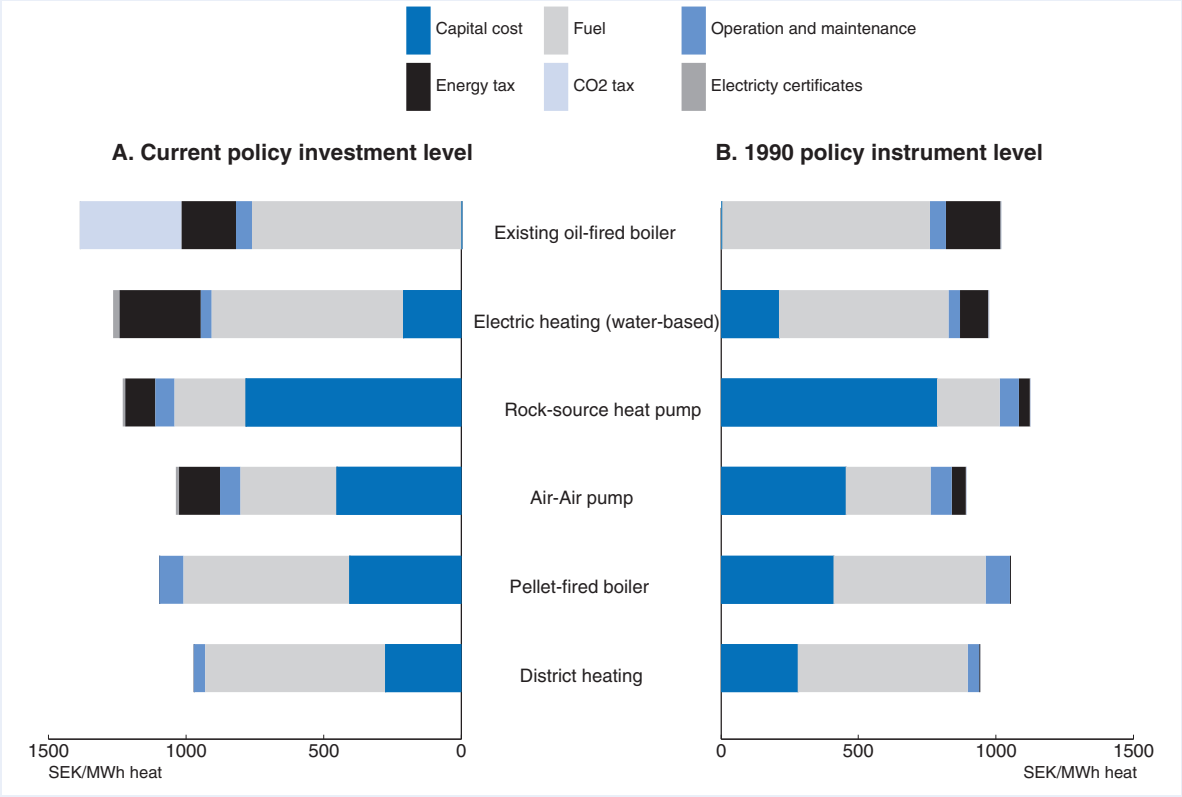
Climate change policy and fiscal sustainability

Many governments face a difficult fiscal situation, while climate change recommendations include the need to increase the "price" of CO_2 emissions through methods such as increasing taxation. Increasing carbon taxation would seem to work towards solving two problems at the same time. Removing the many subsidies to fossil fuel use would also help in the same way; they are equivalent to over one tenth of energy tax revenue in a number of countries (such as the United Kingdom, Canada and Hungary) and more than this in some countries, such as Australia and Brazil (OECD, 2015h).

Box 2.4. **Integrated policies reduced Swedish residential greenhouse gas emissions by 80%**

In 1990, total residential GHG emissions in Sweden were over 6.6 million tonnes CO_2 equivalent. By 2009, they had fallen to under 1.3 million tonnes. Emissions fell despite an increase in per capita residential surface area, as a series of policies pushed Swedes to invest in better homes. The key policies included increasing taxation on oil and gas-fired heating, so that their overall cost increased by up to 30% compared with zero emissions alternatives; tighter building standards; and an energy certification scheme (Ministry of Environment, Sweden, 2014).

Heat production costs in single-family houses with different heating alternatives

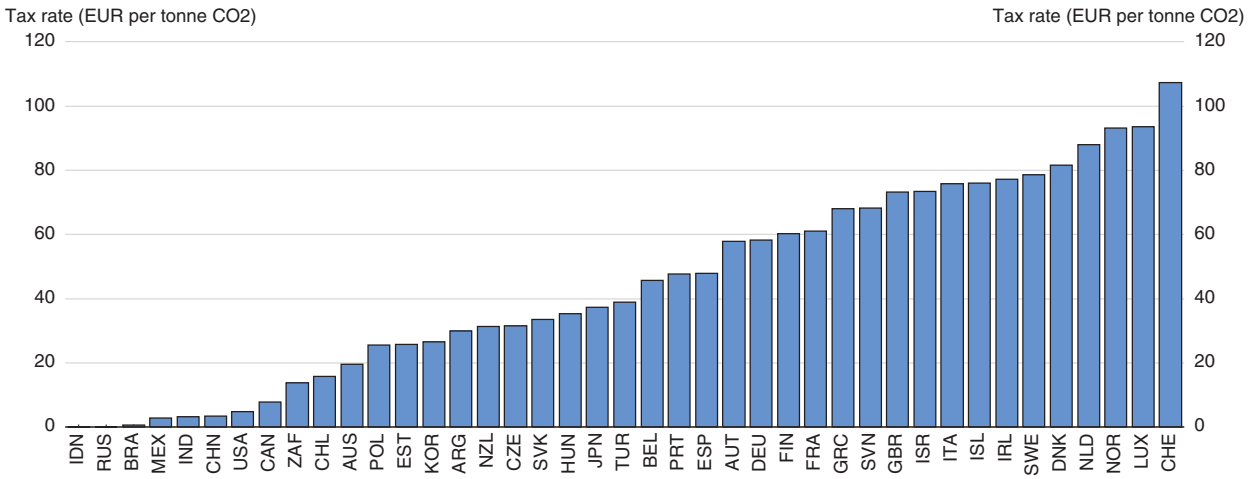


Source: Ministry of the Environment (2014), Sweden's sixth national communication on climate change.

StatLink http://dx.doi.org/10.1787/888933296631

Carbon taxation, in the form of motor fuel tax, already raises a lot of revenue in most countries. Expressed as taxation per unit of CO_2 emitted, motor fuel taxes are much higher than on any other kind of CO_2 emissions (and often higher than estimates of the average tax rate needed to reach mitigation goals). Average tax rates vary widely across countries (Figure 2.5). The rate of explicit taxation is not the same as the carbon "price" notably because some countries have cap-and-trade systems in place. The economic and environmental effect is similar to a carbon tax but they have much less impact on government revenue, since allowances have been mostly issued at no charge, though this proportion tends to decline (in the European Trading System, for instance, 96% of emission allowances were allocated free for 2008-12, while about half will be so allocated for the 2013-20 period).

Figure 2.5. **Economy-wide effective tax rates on CO_2 from energy**[1]



1. 2012 data.

Source: OECD (2015), Taxing Energy Use 2015: OECD and Selected Partner Economies.

StatLink http://dx.doi.org/10.1787/888933296621

Overall revenues from environmental taxation, most of which is energy and transport related, show similar variation, with some countries collecting the equivalent of over 3% of GDP and others less than 1.5%. Some countries could therefore improve their public finances if they adopted taxation nearer the upper end of this scale.

Using environmental tax revenues

Revenues from taxes and charges on GHG emissions could be used in a number of ways. In the case of most taxes, earmarking their revenue to particular purposes is not a good idea, because it makes spending dependent on events or trends in tax bases likely to be irrelevant for the costs and benefits of that particular expenditure. This would seem to be the case in principle with taxation of greenhouse gas emissions. For example, in theory what matters for such taxes (and for so-called "Pigou taxes" in general) is the tax rate on marginal emissions; tax systems with good properties can have a zero average rate provided there is an incentive to reduce pollution at the margin.[7] Such taxes give good incentives to reduce pollution but produce no revenue for the government. From this point of view, revenue from taxes or charges on GHG emissions should be treated as general tax revenue and used to reduce other taxes, reduce debt, or finance general expenditure, according to political choice.

There are nevertheless a number of pragmatic reasons for some earmarking of tax revenues in the case of climate change (see e.g. Grubb *et al.*, 2014). "Getting the price right" is an essential first step to induce behavioural change, but there is evidence that households and businesses are slow to react even when they can save money. Here there is room for "nudging" policies, where small amounts of public expenditure can be used to kick-start a reaction; this could be targeted, temporary, subsidies or publicity campaigns, for example. Many countries provide some form of subsidy to energy-saving home

7. There are not many examples in practice, one is the tax on NOx emissions in Sweden, whose revenues are refunded in proportion to energy use; cap-and-trade systems with free allocation of permits are essentially equivalent.

improvements, in the face of evidence that householders, and especially owners of rental property, do not make these investments despite their cost-effectiveness. Thus, allocating some climate change revenues to such limited and temporary measures is reasonable, especially from a political economy point of view where it can help to sell the idea of the necessary taxes. Nevertheless, governments should always monitor the impact of these programmes which, despite their good intentions, are not always cost effective (Parry et al., 2014; Fowlie et al,. 2015; Ito, 2015).

Another justification for earmarking can be found in the need to fund investment, especially in RD&D. "Getting the price right" and some "nudging" should give the right incentives for private sector investment but some of the investment needed to reduce GHG emissions will be in the public sector itself, such as better building standards for public buildings. Some could be more indirect, such as investment in low-emission vehicles in public transport or subsidies for initial infrastructure needed for electrically powered road vehicles. Again, such investment, or subsidies to encourage it, might be needed for only a temporary period. Finally, using some revenue from climate change measures to finance RD&D makes sense, since it has an essential role in developing a low-carbon economy. Some RD&D can be targeted on specific groups of technologies or materials and pricing may stimulate this directly, but progress often comes from basic research which is more dependent on untied funding from industry or government. In political economy terms, too, such an allocation can help to make the necessary taxes or charges acceptable.

The social safety net and energy subsidies

Many countries use energy subsidies to relieve the burden of high energy prices on particular sections of the population or particular industries. These tend to increase the use of the subsidised energy, which is usually fossil-fuel based, so that GHG emissions are thereby encouraged. The population targeted is usually small so this direct effect may be small, but poor targeting means that the affected group is often much larger so that the unintended effects of poverty-motivated or industry-specific energy subsidies can be significant. They may spread over time, as successive groups argue that they deserve special treatment. They are difficult to remove as they come to be seen as rights. Ultimately their cost can be many times the actual benefit to the targeted group, unless a complex administrative system is set up to control allocation.

In countries with effective social safety nets, energy subsidies (whether through sales tax reductions, price controls, or other means) can simply be replaced with appropriate adjustments to social benefits. The situation is more difficult where the country does not have a well-developed system. In this case the waste of subsidising the well-off as well as the poor may be tolerated, but reform is preferable. Setting up an entire welfare system just to replace energy subsidies is unlikely; such reform would have to be part of a larger package.

Reforms can take advantage of favourable opportunities. For example, Indonesia recently took advantage of lower energy prices to reduce energy subsidies to households at a time when their loss for poorer people was offset by falling market prices. At the same time an income support scheme was introduced, which should deliver better targeted poverty alleviation. The income support scheme in Indonesia may in practice be temporary, and most of the savings have been allocated to such programmes as infrastructure investment or education. IMF (2013) identifies targeted mitigating measures as an element in the success of 18 out of 28 reform episodes. No country where fossil fuel

subsidies have been important has successfully abolished the full range of these subsidies, which should remain a long-term policy priority (OECD, 2015h).

Conclusion

COP21 could be an important step on the road to the zero-carbon economy that is needed to give the world a chance of avoiding the worst consequences of climate change. A clear commitment to a zero-carbon path, along with credible policy programmes across the world to meet that target, would usher in an era of radical change in energy supply and industrial structure. Major investment commitments by both public and private sectors would be needed. While these would be costly, this chapter has argued that there are many reasons to suppose that both the direct effects of increased investment and the indirect effects of reduced risks and gains in confidence will support rather than hinder the recovery.

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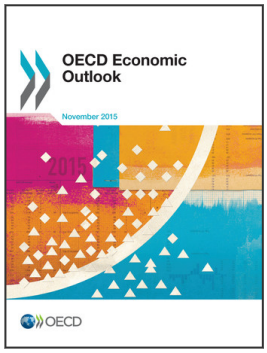

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