

Getting warmer

So far the effort to tackle global warming has achieved little. Copenhagen offers the chance to do better, says Emma Duncan.



Illustration by M. Morgenstern

THE mountain bark beetle is a familiar pest in the forests of British Columbia. Its population rises and falls unpredictably, destroying clumps of pinewood as it peaks which then regenerate as the bug recedes. But Scott Green, who studies forest ecology at the University of Northern British Columbia, says the current outbreak is “unprecedented in recorded history: a natural background-noise disturbance has become a major outbreak. We’re looking at the loss of 80% of our pine forest cover.” Other parts of North America have also been affected, but the damage in British Columbia is particularly severe, and particularly troubling in a province whose economy is dominated by timber.

Three main explanations for this disastrous outbreak suggest themselves. It could be chance. Populations do fluctuate dramatically and unexpectedly. It could be the result of management practices. British Columbia’s woodland is less varied than it used to be, which helps a beetle that prefers pine. Or it could be caused by the higher temperatures that now prevail in northern areas, allowing beetles to breed more often in summer and survive in greater numbers through the winter.

The Framework Convention on Climate Change (UNFCCC), which the United Nations adopted at the Earth Summit in Rio de Janeiro, is now 17 years old. Its aim was “to achieve stabilisation of greenhouse-gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. The Kyoto protocol, which set about realising those aims, was signed in 1997 and came into force in 2005. Its first commitment period runs out in 2012, and implementing a new one is expected to take at least three years, which is why the 15th conference of the parties to the UNFCCC that starts in Copenhagen on December 7th is such a big deal. Without a new global agreement, there is not much chance of averting serious climate change.

Since the UNFCCC was signed, much has changed, though more in the biosphere than the human sphere. According to the Intergovernmental Panel on Climate Change (IPCC), the body set up to establish a scientific consensus on what is happening, heat waves, droughts, floods and serious hurricanes have increased in frequency over the past few decades; it reckons those trends are all likely or very likely to have been caused by human activity and will probably continue. Temperatures by the end of the century might be up by anything from 1.1°C to 6.4°C.

In most of the world the climate changes to date are barely perceptible or hard to pin on warming. In British Columbia and farther north the effects of climate change are clearer. Air temperatures in the Arctic are rising about twice as fast as in the rest of the world. The summer sea ice is thinning and shrinking. The past three years have seen the biggest losses since proper record-keeping started in 1979. Ten years ago scientists reckoned that summer

sea-ice would be gone by the end of this century. Now they expect it to disappear within a decade or so.

Since sea-ice is already in the water, its melting has little effect on sea levels. Those are determined by temperature (warmer water takes up more room) and the size of the Greenland and Antarctic ice caps. The glaciers in south-eastern Greenland have picked up speed. Jakobshavn Isbrae, the largest of them, which drains 6% of Greenland's ice, is now moving at 12km a year—twice as fast as it was when the UNFCCC was signed—and its "calving front", where it breaks down into icebergs, has retreated by 20km in six years. That is part of the reason why the sea level is now rising at 3-3.5mm a year, twice the average annual rate in the 20th century.

As with the mountain bark beetle, it is not entirely clear why this is happening. The glaciers could be retreating because of one of the countless natural oscillations in the climate that scientists do not properly understand. If so, the glacial retreat could well stop, as it did in the middle of the 20th century after a 100-year retreat. But the usual causes of natural variability do not seem to explain the current trend, so scientists incline to the view that it is man-made. It is therefore likely to persist unless mankind starts to behave differently—and there is not much sign of that happening.

Carbon-dioxide emissions are now 30% higher than they were when the UNFCCC was signed 17 years ago. Atmospheric concentrations of CO₂ equivalent (carbon dioxide and other greenhouse gases) reached 430 parts per million last year, compared with 280ppm before the industrial revolution. At the current rate of increase they could more than treble by the end of the century, which would mean a 50% risk of a global temperature increase of 5°C. To put that in context, the current average global temperature is only 5°C warmer than the last ice age. Such a rise would probably lead to fast-melting ice sheets, rising sea levels, drought, disease and collapsing agriculture in poor countries, and mass migration. But nobody really knows, and nobody wants to know.

Some scientists think that the planet is already on an irreversible journey to dangerous warming. A few climate-change sceptics think the problem will right itself. Either may be correct. Predictions about a mechanism as complex as the climate cannot be made with any certainty. But the broad scientific consensus is that serious climate change is a danger, and this newspaper believes that, as an insurance policy against a catastrophe that may never happen, the world needs to adjust its behaviour to try to avert that threat.

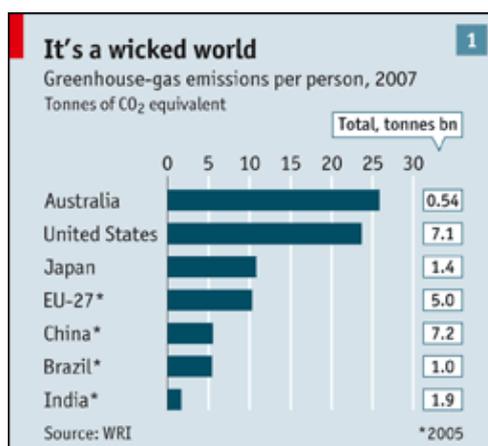
The problem is not a technological one. The human race has almost all the tools it needs to continue leading much the sort of life it has been enjoying without causing a net increase in greenhouse-gas concentrations in the atmosphere. Industrial and agricultural processes can be changed. Electricity can be produced by wind, sunlight, biomass or nuclear reactors, and cars can be powered by biofuels and electricity. Biofuel engines for aircraft still need some work before they are suitable for long-haul flights, but should be available soon.

Nor is it a question of economics. Economists argue over the sums (see article), but broadly agree that greenhouse-gas emissions can be curbed without flattening the world economy.

A hard sell

It is all about politics. Climate change is the hardest political problem the world has ever had to deal with. It is a prisoner's dilemma, a free-rider problem and the tragedy of the commons all rolled into one. At issue is the difficulty of allocating the cost of collective action and trusting other parties to bear their share of the burden. At a city, state and national level, institutions that can resolve such problems have been built up over the centuries. But climate change has

been a worldwide worry for only a couple of decades. Mankind has no framework for it. The UN is a useful talking shop, but it does not get much done.



The closest parallel is the world trading system. This has many achievements to its name, but it is not an encouraging model. Not only is the latest round of negotiations mired in difficulty, but the World Trade Organisation's task is child's play compared with climate change. The benefits of concluding trade deals are certain and accrue in the short term. The benefits of mitigating climate change are uncertain, since scientists are unsure of the scale and consequences of global warming, and will mostly accrue many years hence. The need for action, by contrast, is urgent.

The problem will be solved only if the world economy moves from carbon-intensive to low-carbon—and, in the long term, to zero-carbon—products and processes. That requires businesses to change their investment patterns. And they will do so only if governments give them clear, consistent signals. This special report will argue that so far this has not happened. The policies adopted to avoid dangerous climate change have been partly misconceived and largely inadequate. They have sent too many wrong signals and not enough of the right ones.

That is partly because of the way the Kyoto protocol was designed. By trying to include all the greenhouse gases in a single agreement, it has been less successful than the less ambitious Montreal protocol, which cut ozone-depleting gases fast and cheaply. By including too many countries in detailed negotiations, it has reduced the chances of agreement. And by dividing the world into developed and developing countries, it has deepened a rift that is proving hard to close. Ultimately, though, the international agreement has fallen victim to domestic politics. Voters do not want to bear the cost of their elected leaders' aspirations, and those leaders have not been brave enough to push them.

Copenhagen represents a second chance to make a difference. The aspirations are high, but so are the hurdles. The gap between the parties on the two crucial questions—emissions levels and money—remains large. America's failure so far to pass climate-change legislation means that a legally binding agreement will not be reached at the conference. The talk is of one in Bonn, in six months' time, or in Mexico City in a year.

To suggest that much has gone wrong is not to denigrate the efforts of the many people who have dedicated two decades to this problem. For mankind to get even to the threshold of a global agreement is a marvel. But any global climate deal will work only if the domestic policies through which it is implemented are both efficient and effective. If they are ineffective, nothing will change. If they are inefficient, they will waste money. And if taxpayers decide that green policies are packed with pork, they will turn against them.

Is it worth it?

What economists have to say about mitigating climate change.

EVER since climate change became a subject for public discourse, economists have been making life difficult for environmentalists. Their problem is that mitigating climate change will require sizeable investments. When making investments, governments and companies normally look at rates of return. If an investment looks likely to deliver a decent return, it is worth making. If it doesn't, it isn't.

The trouble with mitigating climate change is that the benefits are uncertain and distant. Compared with investments that deliver clear benefits in the near future—such as education in developing countries, for instance, which commonly produces returns of around 10% a year—they do not look worthwhile. Conventional analysis would therefore suggest that those who want to make the planet a better place should invest in schools in Malawi rather than in clean energy.

Lord Stern, asked by Tony Blair, then Britain's prime minister, to look into the economics of climate change, devoted his report published in 2006 to the question of whether mitigation was worthwhile (or, according to some critics, to justifying a political decision that had already been made). He came out in favour.

The Stern review has since been used as an intellectual prop by greenish politicians everywhere. Economists have been more critical, on two grounds. The first concerns the discount rate—the annual rate at which future costs and benefits are discounted. Lord Stern uses a rate close to zero. A higher rate, often the cost of borrowing money, is more common. The higher the rate, the lower the value of future benefits or costs; and vice versa. Lord Stern agrees with Frank Ramsey, an economist who wrote 80 years ago that discounting “later enjoyments in comparison with earlier ones...is ethically indefensible and arises merely from the weakness of the imagination”.

Other economists feel there is nothing wrong with their imaginations but plenty wrong with Lord Stern's near-zero rate. They think he should have used what William Nordhaus, an economics professor at Yale University, calls “assumptions that are consistent with today's marketplace real interest rates and savings rates”. In a world of limited resources, they point out, it is not obvious that spending them on future generations rather than on the current one is morally right. After all, since future generations will probably be much richer than we are, it makes no more sense for us to sacrifice our well-being for them than it would to expect 18th-century peasants to go without gruel so we can buy more computers. Mr Nordhaus argues for a 3% discount rate, which implies that benefits accrued in 25 years' time are worth about half their current value. He would prefer to spend less money now, and live with more warming, than Lord Stern would.

But others argue against using short-term rates in the long term. Paul Klemperer, an economics professor at Oxford University, points out that very long-term securities carry very low interest rates. When the British government recently issued 40-year index-linked bonds, for instance, it did so at a 0.5% real rate. And over the very long term standard discount rates lead to strange conclusions. At a modest 2% rate, for instance, a single cent rendered unto Caesar in Jesus's time is the equivalent of about \$1.5 quadrillion (or 30 times the value of the entire world economy) today.

Martin Weitzman, an economics professor at Harvard University, is less critical of Lord Stern than Mr Nordhaus is: he thinks the review is “right for the wrong reasons”. Its Leitmotiv, he maintains, is “the immorality of relegating future generations to live under the shadow” of

serious climate change “when for a mere annuity cost of a per cent or two (or at most three) of GDP each year we might have purchased an insurance policy on their behalf”. But, he says, such guilt feelings are likely to lead to the choice of a discount rate that is hard to justify intellectually. “I think that rather than trying to go through the back door with [an] unreasonably low [discount rate]...it is much better to go directly through the front door with the legitimate concern that there is a chance, whose subjective probability is small but diffuse, that global warming may eventually cause disastrous temperatures and environmental catastrophes.”

A premium to buy peace of mind

Most economic analyses of climate change concentrate on the likeliest outcome—the highest point in the probability curve. That, on the basis of the IPCC’s data, would be 2.8°C over the next 100 years. Mr Weitzman reckons they should look instead at events that are less likely to materialise but cannot be ruled out (the right-hand tail of the curve), such as a massive temperature increase within a century. “Societies and ecosystems whose average temperature has changed in the course of a century by more than 6°C are located in the terra incognita of what any honest economic modeller would have to admit is a planet Earth reconfigured as science fiction, since such high temperatures have not existed for some tens of millions of years.” It is worth buying insurance against such an eventuality, he says. Mr Weitzman, thus, succeeds where many others have failed: he manages to reconcile economics with normal human instincts.

Ken Caldeira, an atmospheric scientist at the Carnegie Institution, puts the same point a different way. “If we already had energy and transportation systems that met our needs without using the atmosphere as a waste dump for our carbon- dioxide pollution, and I told you that you could be 2% richer, but all you had to do was acidify the oceans and risk killing off coral reefs and other marine ecosystems, risk melting the ice caps with rapid sea-level rise, shifting weather patterns so that food-growing regions might not be able to produce adequate amounts of food, and so on, would you take all of that environmental risk, just to be 2% richer?” He has, he says, often asked audiences this question; nobody has ever answered “yes”.

The second point on which economists take issue with Lord Stern is his estimate of the cost of mitigating climate change. The review reckons that it would take somewhere between -2% and 5% of gdp per year to limit them to 500-550ppm. At the bottom end of the range, in other words, shifting to clean energy would increase economic growth, whereas at the top it would shrink it. The review plumps for an average cost of around 1% of GDP per year.

The IPCC, the International Energy Agency and McKinsey, a consultancy, tend to agree with Lord Stern. And a piece of recent research, which shows that the cost of cutting pollution often turns out to be less than forecast, supports a modest estimate. Resources For the Future, an American think-tank, looked at regulations on things such as asbestos, power-station emissions and CFCs (refrigerant gases) and found that 12 of the 25 sets of rules it looked at were less expensive to implement than expected and only six were dearer.

But some economists think Lord Stern’s cost estimates are too low. Dieter Helm, professor of energy policy at Oxford University, says the underlying assumptions about the costs of various technologies are likely to prove overoptimistic because they are produced by people who have an interest in exaggerating their viability.

Whether or not Lord Stern has won the argument economically, he has certainly won it politically, for his 1% of GDP figure for the cost of mitigating climate change is now widely used. But a large caveat should accompany any use of that figure, because it assumes that the

policies employed for mitigation will be both efficient and effective—and so far that has not been true. As Mr Helm points out, “there is a voluminous literature of government failure, regulatory capture and the impact of rent-seeking behaviour within the policy process. Climate-change policy is likely to be one of the largest sources of economic rents from policy interventions. There is a large and growing climate-change ‘pork barrel’.” The larger the barrel, the higher the costs of mitigation will be.

The green slump

Why investors have been deserting clean energy.

THE slogan that BP adopted in 2000, “Beyond Petroleum”, was brilliantly unforgettable. It linked the company’s name with the bright, clean future which, the flower/sun logo implied, was to be found on the far side of fossil fuels. But that, as it turned out, was unfortunate, for the company is no longer hurrying towards those fresh green pastures.

BP insists that the role of renewable energy in its strategy has not changed, but admits that investment in it will fall from \$1.4 billion in 2008 to between \$500m and \$1 billion this year. The company is selling some of its renewable-energy assets, including three wind farms in India, and has cut its solar-cell manufacturing capacity in Spain and America. The one renewable-energy source it still seems to be serious about is biofuels.

Shell, which also took a sizeable punt on renewable energy, admits that its strategy has changed. Earlier this year its then chief executive, Jeroen van der Veer, said of wind, solar and hydrogen, “I don’t expect them to grow much at Shell from here.” Further investments in renewable energy, he said, would focus on biofuels. Linda Cook, who resigned in May as head of Shell’s gas and power business, said that wind and solar “struggle to compete with the other investment opportunities we have in our portfolio”.

Whereas policymakers have been scurrying from conference to conference to urge the world on towards a green future, investors have been walking away from it. For one businessman the attendance at the World Business Summit on Climate Change in Copenhagen in May said it all. “There was the usual raft of bigwigs on the panel, but the audience was just hangers-on—journalists, PR people and so forth. There were no serious delegates there.”



The clean-energy business has had a hard year. Investment in the sector tanked in late 2008, as did share prices (see chart 2). Private equity and venture capital held up a little better, but

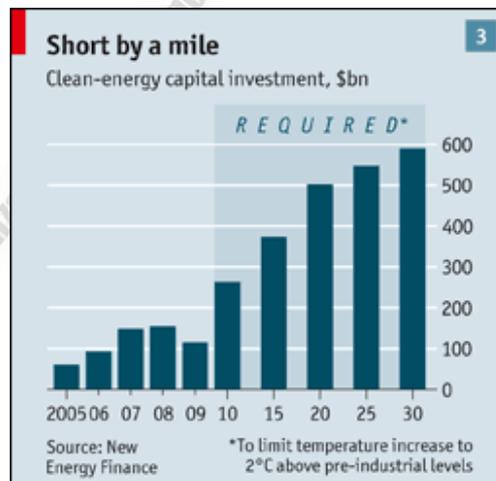
not much. The beginning of 2009 was “scary”, according to Michael Liebreich, chief executive of New Energy Finance, a consultancy.

The industry suffered particularly badly in the credit crunch. Almost by definition, renewable energy sources have low running costs but high up-front costs. And because they are regulated assets with long-term pre-defined revenue streams, they are particularly suited to debt finance, and therefore tend to have high debt-to-equity ratios (typically 80-20). “When the project finance disappears, you’ve got a problem,” says Robert Clover, director of alternative-energy equity research at HSBC. He points out that some of the banks that suffered worst during the crisis—RBS, Lehman Brothers, Washington Mutual and Fortis—were also among the biggest in clean-energy finance.

As the flow of finance to electricity generators dried up, so did the orders to equipment manufacturers. Mr Clover reckons that wind-turbine manufacturers’ order books so far this year are down by 55-60% on the same period in 2008.

But the problem was not just the shortage and cost of capital. The credit crisis also revealed a basic problem with the clean-energy business. Fossil fuels are, in terms of the energy they store, remarkably inexpensive to get out of the ground and sell. That makes dirty industrial processes irresistibly cheap—so long as they are not required to cover the costs of the pollution they cause. Companies cannot be expected to abandon them unless they get a clear signal from consumers or governments that it is in their financial interest to do so. And they are not getting such a signal.

Public awareness of global warming picked up significantly about three years ago. Now most consumers claim to be concerned about it, and public concern is one reason why companies have been branding themselves green. Energy companies boasted of their diversification out of fossil fuels. Businesses with small carbon footprints, such as banks and retailers, promised to go carbon-neutral.



But consumers’ commitment to greenery is rather doubtful. There is a big market for organic products (though it has got smaller since the recession), but shoppers are more concerned about their families’ health than about the planet, and few are prepared to pay premium prices for green products. BA, for instance, has been offering carbon offsets with its flights for the past four years, but finds that only around 3% of customers buy them.

In the absence of pressure from consumers, governments need to give businesses a shove. That was the idea behind the Kyoto protocol, which aims to cut greenhouse-gas emissions by getting countries to accept binding targets with timetables attached. It divided the world into developed countries, which are required to cut their emissions, and developing countries,

which are not. When rich countries ratify the protocol, they have to commit themselves to reducing their emissions by a certain percentage below a date of their choosing (mostly 1990)—Britain by 12.5%, Japan and Canada by 6%, and so on. The idea is that in order to meet these targets governments should introduce policies that send price signals to businesses to shift investment away from dirty products and processes to cleaner ones.

Global carbon-dioxide emissions have risen by 20% since the protocol was signed in 1997, so the plan has evidently not worked all that well. There are three main reasons for that. First, rich countries have exported some of their dirty industry to the developing world. Steel, cement, cars, fridges, computers, toasters, kettles and all the paraphernalia of modern life the production of which used to cause pollution in developed countries are now made in China and other developing countries where emissions are not capped—and have risen partly as a result of that shift.

Second, the world's biggest emitter when Kyoto was signed, America, has not ratified the protocol, and the biggest polluter per person among countries with significant emissions, Australia, did so only two years ago. It might reasonably be argued that the blame should fall on those countries' governments, rather than on the treaty itself; but a treaty in which the most important parties play no part cannot be said to be a success.

Third, some countries have failed to cut their emissions as promised. In 2007 Canada's emissions were 29% above their 1990 level and Spain's 57%. But there is no need for them to miss their targets, thanks to the countries of the former Soviet Union. Their dirty industries collapsed during the 1990s, so they are awash with carbon credits that can be bought for a small consideration. Countries in danger of failing to meet their Kyoto targets can simply buy what is known in the industry as "Russian hot air". As the 2012 deadline for meeting Kyoto targets approaches, there is a growing appetite for those meaningless credits.

Even in countries that have cut their emissions substantially, business is not always getting the right signals. Britain's apparently creditable performance, for instance, is less the result of a well-designed policy than the "dash for gas" in the 1980s, spurred by the hostility to the coal industry of its then prime minister, Margaret Thatcher. Attempts to get a renewable-energy industry going have flopped.

Britain is not alone in finding it hard to work out how to send business the right signals. Policies that are effective, efficient and politically palatable have proved elusive everywhere.

Good policy, and bad

Some mitigation policies are effective, some are efficient, and some are neither.

GREENHOUSE-GAS emissions targets can be implemented through three sorts of policy instruments—regulation, carbon-pricing and subsidies. Governments generally like regulation (because it appears to be cost-free), economists like carbon prices (because they are efficient) and businesses like subsidies (because they get the handouts).

Regulation can be useful where the market is not working well. Buildings are rarely designed to save energy, because those who put them up do not usually pay the bills and those who occupy them choose them for their views or their looks, not their energy-efficiency. The same goes for appliances, most of which do not use enough energy to affect consumers' choices. Small regulatory changes (see box, next page) can cut energy consumption without distorting the market much. According to McKinsey, around one-third of the required greenhouse-gas reductions will actually save money.

Two-thirds, however, will not. They can be achieved only if companies invest in more expensive, cleaner technology. That will happen only if governments require them to do so, or tax dirty products and processes (through a carbon price), or subsidise clean ones.

Carbon pricing keeps government out of management decisions and allows managers to choose between different ways of cutting carbon. According to a paper by Carolyn Fischer, of Resources for the Future, and Richard Newell, head of America's Energy Information Administration, a carbon price is around twice as efficient as a renewable portfolio standard (which requires power companies to generate a certain proportion of the power they sell from renewable sources) and about two-and-a-half times as efficient as a renewable-energy subsidy.

A carbon price can be set either by a tax or through a cap-and-trade system. Europe already has such a system and America, Australia and Japan are trying to set one up. Norway and Sweden have carbon taxes and France soon will (though none of them covers much of those countries' economies). The European Commission is also now looking at a tax. Both methods have advantages and drawbacks, but tax wins out for simplicity and stability.

More important than the way the price is set, though, is its level. It needs to be high enough to send an unmistakable signal to business. According to Dimitri Zenghelis, one of the authors of the Stern Review and a senior adviser to Cisco and the Grantham Research Institute, a \$40 carbon price now, doubling by 2050, and combined with non-price policies such as appliance standards and R&D support, is needed to hit the 450ppm target.

The European Union's Emissions-Trading Scheme, which started up in 2005, is the only large-scale attempt so far to set a carbon price. Under the ETS, EU countries get national allocations which they then parcel out to over 11,500 factories in five dirty industries. Companies can buy and sell allocations amongst themselves, and can also buy "certified emission reductions" from developing countries to meet their caps through Kyoto's "clean development mechanism".

Europe's flagship

The ETS makes up the vast bulk of the global carbon market, which will be worth around \$122 billion this year. It is the principal way of financing the shift from high- to low-carbon power and industrial processes in the developing world. A wind farm in India; a methane-capture scheme for pig farms in Brazil; a forestry project in Indonesia; equipment to capture industrial gases in China—the ETS can finance them all.

Although it is still young, the ETS has had some impact on emissions. According to a 2008 study at the Massachusetts Institute of Technology, in its first three years it probably reduced them by 120m-300m tonnes, or 2-5% a year, below what they would otherwise have been.

Power companies and manufacturers factor a carbon price into their investment decisions these days. At €15 (\$22) a tonne the price is high enough to induce power companies to switch some generation from coal to gas at the margin, but not high enough to encourage much innovation.

Blame politics. The price is determined by the cap, which is set by the European Commission in consultation with member states. Initially, member states overestimated their emissions in order to get lots of permits, so the carbon price was lower than the commission had expected. For the second phase of allocations, from 2008, member states fought vigorously to get more permits than their neighbours. Some sued the commission and, in September 2009, won. The price dipped again.

Thanks to a combination of recession and lack of political will, most estimates of the future level of Europe's carbon price have been revised sharply downwards this year. And if America gets a carbon price, it is unlikely to be high enough to make much difference. According to America's Environmental Protection Agency, the legislation Congress is now considering would set it at \$12 a tonne in 2012, rising to \$20 in 2020. That, by itself, is unlikely to encourage much new investment, so if America is to make a dent in its emissions, it will have to rely mostly on subsidies.

There is an argument for some of those. Basic R&D in new energy technologies—in carbon capture and storage, for instance, which would allow the continued use of coal to generate electricity—is too risky for most companies to undertake on their own, and offers enough social benefits to deserve government support. But the subsidies now on offer go far beyond that.

Governments are spending heavily on encouraging the switch to low-carbon technologies, especially wind and solar power. "These policies are not particularly efficient, but they have been quite effective," says Guy Turner, director of carbon markets at New Energy Finance. Some 50% of new power capacity added in the EU in 2000-06 was renewable energy, compared with 29% in 1990-2000.

This sort of energy is expensive. The best indication of that is the carbon price that would be required to make investment in renewables worthwhile without subsidy. According to New Energy Finance, onshore wind energy needs a carbon price of \$38, offshore of \$136 and solar cells of \$196. Europe's target for generating 20% of its energy from renewable sources therefore looks pricey. According to Richard Green, director of the Institute for Energy Research and Policy at Birmingham University, the implied marginal cost of carbon would be €129 a tonne—which suggests that allocating such large resources to renewable-energy subsidies is, as Mr Green says, "seriously sub-optimal".

The worst example of a wasteful subsidy is America's support programme for home-grown corn ethanol, which is coupled with tariffs on cheaper sugar-cane ethanol from Brazil. The programme has raised global food prices (and thus increased malnutrition among the world's poorest); lined the pockets of America's farmers; given policies to cut carbon a bad name; and cut little, if any, carbon.

Solar flare

Europe has yet to devise a policy quite so disastrous, but Spain's solar subsidy comes a close second. Its feed-in tariff for solar energy, established in 2007, offered generators 44 euro cents per kilowatt-hour. Coal-fired power costs around 4 cents per kwh to generate. The tariff was supposed to be for small-scale projects, of 100kw or less; but generators found that they could get it for larger ones if they installed banks of 100kw modules next to each other.

The resulting boom benefited manufacturers not just in Spain but also in Germany and China, the biggest producers of solar cells. Last year Spain accounted for 40% of world demand. The government had planned for 400MW of solar capacity to be built by 2010. In the event, 3GW was built. Panicking about the commitments it was building up, the government announced that rates would drop to 32 cents on September 29th 2008. "There were all sorts of abuses," says Jenny Chase, solar analyst at New Energy Finance. "If you connected a single module to the grid before September 29th, your whole project got financed. So modules were changing hands for vast sums of money." After the deadline the market collapsed.

The Spanish crash hit silicon-wafer producers, the manufacturers of equipment for solar-cell producers and the makers of cells across the world. Prices across the industry crashed by 30-40%, and solar companies' share prices fell by 50-75% in 2008, though they have picked up a

bit this year. Some 20,000 jobs have been lost in the solar industry in Spain over the past year, and plenty more elsewhere.

Europe's energy subsidies, unlike America's, do not include nuclear, largely because of German opposition (which may change, following Angela Merkel's recent election victory). Nuclear power is more expensive than coal and gas, but probably cheaper than most renewables—though nobody is sure, since political opposition has ensured that few plants have been built in the West in recent years. Nuclear power does, however, have the virtue of scale. For renewables a gigawatt of power is a massive amount; for nuclear power it is the basic unit.

Thanks to stimulus money to combat the recession, subsidies are now flooding into the renewable-energy business faster than ever before. Governments across the world have trumpeted their stimulus packages as a way of saving the world economy and the planet at the same time. Green stimulus money globally adds up to around \$163 billion, according to New Energy Finance, of which more than \$100 billion is being spent in America and China. The biggest chunk, around a quarter, is going on improving energy efficiency. Grid development is next, with a fifth.

The green stimulus money has been slow in coming. In America it started to flow in the second half of this year, just as the economy began to recover. Some of it has been used to extend the tax credits for wind and solar energy and to convert some of the tax-credit schemes into grants. As a result, wind developers in America now get a cheque for 30% of the cost of the project once they connect to the grid. That scheme runs out at the end of next year.

Mr Clover is concerned about the likely effect. "We're expecting a stampede in 2010. The danger is that you just bring forward demand. That's been a key feature of the US market. We've already seen several subsidy cycles—very high installations followed by complete cessations of activity. All anybody wants is long-term regulatory stability." He hopes that will come with the imposition of a federal renewable portfolio standard on generators, which would require them to sell a certain proportion of renewable electricity as part of the mix.

Globally, New Energy Finance reckons that only \$24 billion of green-stimulus money will be disbursed this year, with another \$58 billion to follow in 2010 and a further \$56 billion in 2011. So it looks as though the money will come too late to temper the recession of 2008-09, and may instead fuel another inflationary boom in a couple of years' time.

Vampires on a diet

How a boring gadget saved \$2 billion-worth of electricity.

THE dullest bits of the many electronic devices people plug into mains sockets in their houses and offices are the power adaptors. These are boxes that sit between the plug and the device, or are sometimes integrated with the plug. Their job is to convert high-voltage alternating current from the mains into low-voltage direct current for mobile phones, laptops, iPods and other electronic gadgets. About 5 billion such devices are in use worldwide.

Until recently the conversion was made using copper wire. Typically, half the power they drew from the wall, and sometimes as much as 80%, would be lost in conversion. As a result, electricity bills and carbon emissions were both higher than necessary.

Making the conversion with integrated circuits is much more efficient, with as little as 20% of the power being lost. The technology for this has been available for many years and costs only around 30% more than the copper-wire method, but the market gave manufacturers little

incentive to switch. Power adaptors are cheap, usually costing \$2 or less. Appliance-makers tend to buy them from companies in Taiwan or China. Contracts are won and lost on a fraction of a cent per unit. And since consumers do not think about power consumption when choosing a phone or laptop, manufacturers tended to stick with copper wire.

Seven years ago the Natural Resources Defence Council and Ecos Consulting, an energy consultancy, got manufacturers, power utilities and the state and federal governments together to talk about shifting to integrated circuits. It took two years to get regulations in place in America. Once adopted in the world's biggest market, integrated-circuit adaptors spread swiftly everywhere, because manufacturers cannot afford to make things that cannot be sold in America.

For consumers the switch has meant lower power bills and smaller, lighter power adaptors. For the world as a whole it has meant a drop in global power consumption worth around \$2 billion a year—saving 13m tonnes of CO2 annually worldwide, the equivalent of closing down eight coal-fired power stations.

There are plenty more such savings available, says Chris Calwell of Ecos Consulting. The biggest potential is in large-screen televisions, cable and satellite set-top boxes and battery chargers. Millions of devices—known to energy-efficiency experts as “vampires”—continue to suck in electricity even when the device that sits in them is fully charged.

Cap and tirade

America struggles with climate-change legislation.



Illustration by M. Morgenstern

“WHAT that means in code”, Senator Bob Corker, a conservative Republican from Tennessee, told the audience at a hearing of the Senate Committee on Energy and Natural Resources about America's proposed climate-change legislation, “is we're transferring wealth from our companies and our citizens...to raise carbon prices and send money abroad.”

Senator Maria Cantwell, a left-wing Democrat from Washington, does not normally agree with Mr Corker, but her line of reasoning was similar. In costing the bill, she said, the Environmental Protection Agency had estimated that \$1.4 trillion dollars a year would go abroad to cover the generous provision for offsets in the bill. “What can we buy abroad for that? Can't we spend this money on developing technology at home?” Senator Corker was fairly sure that the foreigners would find things to sell America. “When \$1 trillion comes around there are hucksters all over the world who will do business with you.”

After eight years of resistance from the Bush administration, America may be about to get mandatory federal greenhouse-gas emissions controls. The House of Representatives has passed the American Clean Energy and Security Act, otherwise known as the Waxman-Markey bill. It is sponsored by two powerful Democrats, Henry Waxman, chairman of the House Committee on Energy and Commerce, and Edward Markey, chairman of the Subcommittee on Energy and Environment.

The bill steers a difficult course between the demands of environmentalists and those of business. In attempting to bring emissions down by 17% below 2005 by 2020, or 4% below 1990 levels, it aims low by the standards of other rich countries, but is under attack in America on the ground that it will hurt the economy. In a cap-and-trade system designed purely for efficiency all permits would be auctioned, which is what Mr Obama wanted. But as a result of concessions made in committee, by the time it was passed, 85% were to be given away initially (though some of the value of the giveaways will be returned to power consumers as rebates).

Even so, the bill is struggling. It got through the House by a mere seven votes and has got stuck in the Senate. The Kerry-Boxer bill (the Senate version of Waxman-Markey) has fallen victim to many factors. One is health care, which has used up a lot of political time and energy and generated much ill will between the parties. Republican former supporters of cap-and-trade—such as John McCain, Richard Lugar and Lisa Murkowski—have become unwilling to do the president any favours. Another is public attitudes (see article).

The distribution of Senate seats does not help. Americans on the coasts are more willing than those in the hinterland to mitigate climate change, partly because they are more liberal, partly because they are less reliant on coal and partly because they are more worried by hurricanes and rising sea levels; yet coastal Americans are vastly under-represented because their states are more heavily populated than those inland and every state gets two Senate seats. And since a bill needs 60 votes out of 100 to pass through the Senate, senators representing a mere 11% of the population can block that passage. The biggest problem for the bill, however, is that much of business has weighed in against it.

Business, ironically, was largely responsible for Waxman-Markey's inception. In 2007 a group called USCAP, made up of environmental organisations and companies that wanted legislation, proposed a cap-and-trade bill, and Waxman-Markey looks a lot like their proposal. Some of those companies (such as Exelon and PG&E) were power utilities with little or no coal-fired generation; some (such as GE and Alstom) were equipment companies that would benefit from regulations requiring their customers to buy new kit.

Waking a sleeping bear

But oil companies and energy-intensive manufacturers tend to fear carbon caps, and once the bill started trundling through Congress those companies were stirred into action. "It was like poking a sleeping bear," says Elizabeth Moler at Exelon, the largest nuclear-power generator in America. Powerful trade associations such as the National Association of Manufacturers, the American Petroleum Institute and the US Chamber of Commerce started to lobby heavily against it.

The energy companies' voices tend to be heard loud and clear in Washington, DC. According to the Centre for Responsive Politics, the energy industry has been the fourth-biggest spender this year out of 13 sectors. In the first ten months of this year it lavished \$300m on 2,225 lobbyists in Washington, DC. It handed twice as much in campaign contributions to the bill's opponents in Congress than to its supporters.

These days it is considered bad form to say that the planet can go boil itself, so rather than denying that the globe is warming, corporate critics of the bill tend to argue that cap-and-trade is the wrong remedy. Some, such as ExxonMobil, actually advocate a tax (which is unlikely to materialise).

The move to give away, rather than auction, permits has been much criticised. But perhaps the most contentious aspect of the bill is its generous provision for the use of offsets—the matter which exercised Senators Corker and Cantwell. Offsets are popular among developing countries because they provide an income, and among businesses in rich countries because they keep down the cost of compliance. The Environmental Protection Agency says that without the contribution from offsets, the carbon price under the cap-and-trade system would be twice as high as it is now.

Yet there are worries about the authenticity of offsets. That is partly because they are vulnerable to fraud, but mainly for deeper and more philosophical reasons. Offsets are based on the idea of “additionality”—that the credit is being issued for a cut in emissions which would not otherwise have taken place. Within the Clean Development Mechanism (CDM) of the Kyoto protocol, which creates most international offsets, projects have to be certified as producing “additional” cuts by the CDM’s executive board.

But Michael Wara, an expert on environmental law at Stanford University, argues that it is in practice impossible for the board to know that the projects they approve would not have happened otherwise, and indeed some of the projects that have been financed look as though they might have. He cites some 20 gas-fired power stations in China that were partly financed by the CDM (and thus, indirectly, by European consumers). Given that China long ago announced its intention to diversify out of coal for reasons unconnected with climate change, he reckons that those power stations would have been built anyway, so the emissions cuts they led to were not additional. Senator Corker shares his scepticism about offsets. “That’s not a market,” says the senator. “That’s Alice in Wonderland make-believe.”

The Waxman-Markey bill covers more of the American economy than the ETS does of Europe’s, and takes a far more generous approach to offsets. As a result, the American offset market would be 20-50 times larger than the existing CDM market, says Mr Wara. This could pose problems. The CDM board’s approval rate has declined lately because it is determined not to issue dodgy credits. With a market as large as America promises to create, there is a risk that there will not be enough offsets available, or that they will be suspect. Senator John Barrasso, a Republican from Wyoming who sits on the energy committee, predicts that it will be “rife with green-collar crime”.

Marketphobia

Arguments about offsets and volatility have raged since cap-and-trade was invented. But this year its supporters face a new problem: a post-credit-crunch hostility to markets in general. For Jason Grumet, who as executive director of America’s National Commission on Energy Policy has been pushing cap-and-trade legislation for years, “mistrust of the market is as big a challenge to getting the legislation through as concerns about costs.” In the House it led to emendations of the bill to restrict trading in carbon derivatives—and thus both the scope for banks to make money and the usefulness of the market.

Senator Murkowski, a Republican from Alaska, co-sponsored a previous bill to curb emissions because she was worried about the effect of climate change on the coastline. But a bill like Waxman-Markey may not get her support. “There’s a concern that we’re creating a new \$1 trillion market that will be susceptible to being manipulated by Wall Street in the same way as mortgage-backed securities were.”

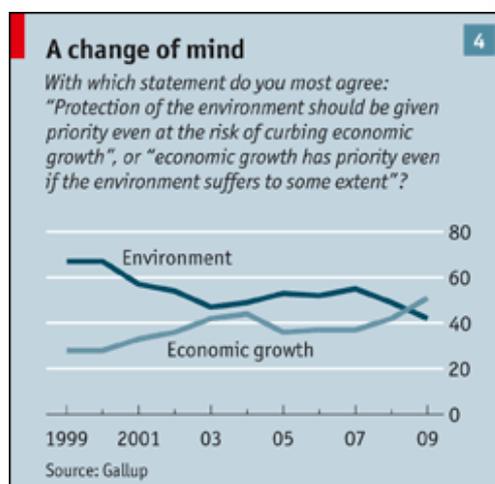
This new-found scepticism about market mechanisms leaves supporters of carbon curbs in some despair. “There’s no question that a tax would be much easier to implement,” Mr Grumet told the Senate’s energy committee. “If there were a serious bipartisan effort to garner support for such a measure it would gather a head of steam.” But so far there isn’t.

Harry Reid, the Senate majority leader, has said there will be a vote on an economy-wide bill next spring. But given the opposition to such a system, other outcomes are possible. One is regulation. The EPA is required by a Supreme Court decision to regulate greenhouse-gases as pollutants under the Clean Air Act—a prospect so alarming to business that it increases the chances of legislation. There is also talk of a more limited cap-and-trade system, covering the power utilities, which are reconciled to the idea, but excluding the oil industry, which is still fiercely resisting it.

With mid-term elections next autumn, a bill on such a sensitive issue will need to pass before summer. Much depends on the president. If he puts his back behind Waxman-Markey, America may get a weakened version of a second-best policy. If he doesn't, America may get something worse—or nothing at all.

Who cares?

Don't count on public opinion to support mitigation.



AMERICANS support the idea of controlling emissions. In a poll published in October by the Pew Research Centre, 50% of those who had an opinion supported limits, compared with 39% against. Other polls have shown higher levels of support. But that apparent enthusiasm is qualified by a number of factors.

The first is price sensitivity. In a poll in August, 58% said they would support a cap-and-trade system that increased monthly electricity bills by \$10, but for an increase of \$25 the figure dropped to 39%.

Second, ignorance and indifference are rife. Whereas half of the respondents to the Pew poll who knew about cap-and-trade supported the idea, 55% had never heard of it. In a Gallup poll in September, 1% cited the environment as America's most important problem, 26% health care and 29% the economy.

Third, scepticism seems to be on the rise. The Pew poll showed a fall in the proportion of Americans who thought there was solid evidence of rising global temperatures, from 71% in April 2008 to 57% in October 2009. The proportion blaming rising temperatures on human activity also fell over the period, from 47% to 36%.

It is hard to see how scientific developments could be responsible for this shift. It seems more likely to be the result of economics. When people are poorer they may be less willing to

support policies that will cost them money, but feel uncomfortable about jeopardising the planet's future to fatten their bank balance. Scepticism absolves them of selfishness.

Figures from other countries support the idea that attitudes have changed during—and possibly as a result of—the recession. A poll published by the European Commission showed a fall in the number of EU citizens who saw climate change as the world's gravest problem from 62% in spring 2008 to 50% in July 2009. Over the same period the proportion citing global recession as their main concern rose from 24% to 52%.

In Australia, meanwhile, where Kevin Rudd's support for mitigation helped him win the 2007 election—probably the first election anywhere in which climate change played a serious part—a poll published in July by the Lowy Institute showed that the proportion of voters who were prepared to shoulder “significant costs” to tackle global warming had fallen to 48% from 68% in 2006.

A long game

China sees opportunities as well as dangers in climate change.



UNLIKE America's leaders, China's bosses are not much troubled by recalcitrant legislatures. The government has therefore had no difficulty in executing a smart volte face on climate change. Around three years ago its fierce resistance to the notion of any limit on its greenhouse-gas emissions started to soften. It now seems to be making serious efforts to control them.

One reason for this change is the country's growing awareness of its vulnerability to a warming world. The monsoon seems to be weakening, travelling less far inland and dumping its rainfall on the coasts. As a result China is seeing floods in the south-east and droughts in the north-west. At the same time the country's leaders are deeply concerned about the melting of the glaciers on the Tibetan plateau, which feed not just the Ganges, the Indus, the Brahmaputra and the Mekong but also the Yangzi and Yellow rivers (see map).

A second reason is China's growing sense of global responsibility. The country is not only the world's largest emitter of greenhouse gases; it now regards itself, and is regarded, as one of the world's leading powers, and therefore expects to work with the other big powers to tackle global problems such as the economic crisis, nuclear proliferation and climate change.

A third reason is energy security. Although China has large coal reserves, it is also a big importer. Concerns about excessive dependence on foreign fossil fuels sharpened when China's oil imports rocketed and, in 2005, the attempt by CNOOC, China's largest offshore oil and gas

company, to buy America's Unocal was rebuffed. China's push into nuclear and renewable energy has been driven by its need to diversify its energy sources.

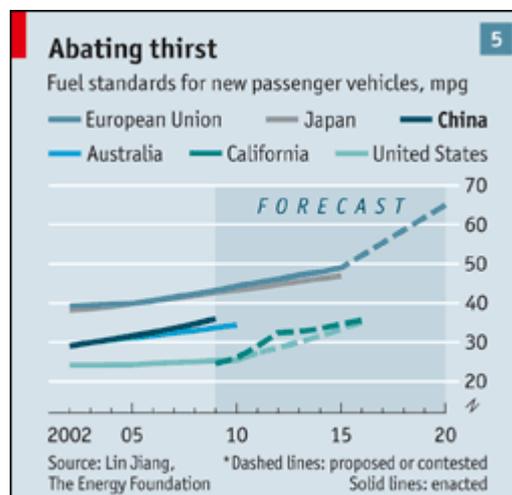
The fourth reason is economic. The Kyoto protocol has given China an incentive to clean up its act. China has received \$2 billion through the CDM for cleaning up its industrial processes and building clean-energy capacity—half the money that has flowed through the CDM. That is expected to rise to \$8 billion by 2012.

But a longer-term economic motive springs from a shift in the way China thinks about growth. In the past, its all-out drive for growth has led it to rebuff pressure to cut emissions. Attempts to control pollution foundered on the performance-assessment system for officials at all levels of government, which prioritises growth. But that has been adjusted to encourage energy efficiency, and at the same time the leadership has started to argue that growth and greenery are compatible.

Since Wen Jiabao took over as prime minister, the leadership has tried to define economic growth as something broader and longer-term than GDP figures imply: the emphasis has been on a "harmonious society" and "scientific development". Nobody was sure what the latter meant, but Mr Wen has recently been talking about a more "resource-efficient environmentally friendly society" and Hu Jintao, the president, has referred several times to a "low-carbon economy" and a "green economy".

Local pollution may help to explain the shift. Residents are infuriated by filthy air and water that kills people and damages unborn children. Policies to cut carbon-dioxide emissions—through reducing the energy used to produce goods—can help clean up China's cities at the same time.

More interesting is the idea that clean energy might be a source of growth rather than a constraint on it. China, so the argument goes, missed out on the computer revolution. It makes hardware, but American firms own most of the valuable stuff—the intellectual property for the software. "You can't get rich making socks and toys," explains Lin Jiang, director of the China Sustainable Energy Programme at the Energy Foundation in San Francisco. "They're looking for the next growth industry. Clean energy clearly has huge potential. And no country dominates the industry yet. It's a wide-open field." Hu Angang, an economist at Tsinghua University, calls this "a huge opportunity for China. The country will become the largest renewable-energy market, bio-energy market, clean-coal market, nuclear-power market, carbon-exchange market, environmental-technology market, low-carbon economy, exporter of low-carbon products and low-carbon-technology innovator."



The government is giving the economy a shove in that direction. In 2006 the five-year plan set a target for a 20% cut in the energy intensity of GDP by the end of 2010. The start was slow, but by the end of last year it had managed 10% and it now looks on track for its target. According to Mr Lin, that would mean a reduction in carbon emissions of 1.5 billion tonnes per year by 2010, more than the Waxman-Markey bill's caps for domestic industry would take out of America's economy by 2020. China has relatively tight vehicle fuel-efficiency standards (see chart 5). Electric vehicles are being generously subsidised (\$8,800 for a car and \$73,500 for a bus) and the government plans to build the capacity to produce half a million a year by 2012.

The most visible changes have come in renewable energy. In 2005 the National People's Congress passed legislation to offer subsidies for renewable energy—around twice the amount for coal. For wind energy, the target was set at 20GW of capacity by 2020. The subsidy generated so much building that China now expects to hit that target by the end of this year and is aiming for 150GW by 2020. "It's like a gold rush right now," says Mr Lin. The target for solar energy, similarly, has been raised from 1.8GW to 20GW by 2020.

To put this in context, wind currently generates only 0.4% of Chinese electricity. Coal generates 80%. And, although China's government does not have to jump the legislative hurdles faced by America's president, it sometimes struggles to get policy implemented on the ground. Yet if China's many layers of government can be persuaded that green means growth, they will cleave to this policy; and the leadership seems keen to make that happen.

China, thus, is after the same "green jobs" that Americans have been promised as part of their road to economic recovery. America has huge advantages in terms of technology and capital, but China has a couple of things going for it too: cheaper labour and a leadership unconstrained by the need to get re-elected every four years. China can play a long game, which helps when dealing with climate change.

Closing the gaps

How the world divides on a global deal.

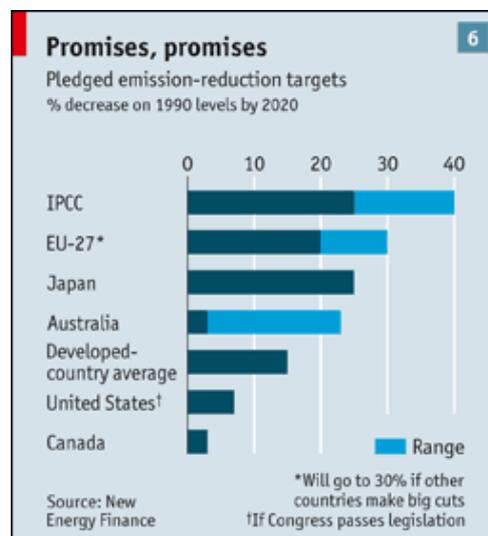


Illustration by M. Morgenstern

BEYOND the planet-saving rhetoric, the argument at Copenhagen and beyond will be about emissions levels and money. On both, large gaps need to be closed for a deal to be reached. The main gap on emissions levels is between America and the rest of the world. The main gap on money is between the developed and the developing worlds.

To establish the size of the emissions cuts needed, you have to start with where you want to end up and work backwards. The G8 group of nations agreed in Italy earlier this year that the increase in global temperatures should be no more than 2°C above pre-industrial levels. To

achieve that, according to the models on which the IPCC bases its calculations, global emissions will have to be cut to half their 1990 levels by 2050. For rich countries that means an 80% cut in their emissions by that date, a reduction to two tonnes of CO2 equivalent per head per year. At present, emissions in America are around 24 tonnes per head; in Europe they are ten.



Forty years is a long time. Governments can agree to meet distant targets in the comfortable knowledge that they will not be held responsible for failing to do so. Shorter-term targets are therefore more important. The IPCC's figures suggest the developed world should aim to cut by 25-40% below 1990 levels by 2020. That will be a stretch, since the targets that developed countries have put on the table so far add up to around 15% below 1990 (see chart 6).

The European Union is committed to a 20% cut, rising to 30% if the rest of the world promises significant cuts. It has a detailed plan for getting there, including lower country caps in its Emissions-Trading Scheme and regulations on car emissions. Japan's new government has promised a reduction of 25% on 1990, but has revealed little about how it might manage that. Australia's government struggled trying to get its legislation through parliament. Canada's emissions continue to grow.

Two weeks before the Copenhagen conference, Mr Obama announced that America would offer a 17% cut on 2005 emissions by 2020—the figure in the Waxman-Markey bill. That's around 4% below 1990 levels—well below the figure of 25-40% that is expected of developed countries—but it is possible that other countries might accept it. Because of the attitude of the Senate and the Bush administration, America is starting to cut later than other developed countries, so it is bound to take some time to catch up. Its negotiators will offer more impressive sounding medium-term figures—17% over 1990 by 2025, or 30% over 1990 by 2030. According to Todd Stern, America's special envoy on climate change, "Several different countries have come up to me and said, 'You've got a path that's pretty good even if we don't like your 2020 number'."

And the rest of the world knows that America's negotiators are constrained by the precarious position of the legislation. The Senate reacts badly if it senses that America is being pushed around by foreigners. It voted 95-0 to reject the Kyoto deal that the Clinton administration had negotiated. If it thinks that the Obama administration is caving in to international pressure it might reject not just the treaty but also the legislation.

The chances of legislation getting through the Senate—and the chances of a deal being done at Copenhagen—were given a boost by China's announcement, a day after Mr Obama's, of a

number of its own. According to the "road map" drawn up two years ago at the UNFCCC conference in Bali, developing countries are not required to come up with numerical targets for cuts, but they are required to propose "nationally appropriate mitigation and adaptation actions".

Because it is the world's biggest emitter, and because of its falling out with America over Kyoto, China has been under particular pressure to come up with a significant "action" of some sort. It has offered a 40-45% cut in the carbon intensity of its economy by 2020. That's less than America was hoping for—it reckoned the figure should be at least 50%, since China would get to 40-45% on the basis of its existing policies—but China's number is an opening bid, and there is relief all round that it has come up with one at all.

Assuming that all the countries involved can produce satisfactory plans that the others sign off on, there will then be carrots and sticks to hold them to their promises. In theory Kyoto is a legally binding agreement with a compliance mechanism. In practice it is toothless, partly because of the availability of "hot air" from the countries of the former Soviet Union for rich countries to buy to meet their targets. But even without the hot air, there is no effective way of holding non-complying countries to account, for the compliance mechanism merely imposes punitively large cuts in the next period on countries failing to meet their targets in this one. That is not going to happen.

France would like something much toothier: trade sanctions, more politely known as "border-tax adjustments". These, in the view of some, would serve both to keep countries to the commitments they had made, and to prevent factories moving from rich countries to poor ones. The threat of tariffs has got some momentum in America too, and the Waxman-Markey bill includes a provision for border-tax adjustments.

Money-shaped carrots

To most developing countries this is poison. China's ministry of commerce said the measure "will not help any country's endeavours during the climate-change negotiations, and China is strongly opposed to it". Mr Obama is with the Chinese. "At a time when the economy worldwide is still deep in recession and we've seen a significant drop in global trade," he said after the House of Representatives passed the Waxman-Markey bill, "I think we have to be very careful about sending any protectionist signals out there."

The carrot to get developing countries to honour their commitments is money. There are two reasons for rich countries to cough up as part of a Copenhagen deal. The first is a moral one. It is widely accepted that since the developed world is responsible for pumping 200 years-worth of carbon dioxide into the atmosphere, it should help the developing world adapt to climate change. The second is a pragmatic one. China aside, many developing countries lack the capital to invest in cleaning up their economies, so if they cannot get access to rich-world capital, the investment will not happen.

China says that the developed world should hand over 1% of its GDP, or about \$400 billion a year. The African Union wants \$67 billion a year for Africa alone. Britain's prime minister, Gordon Brown, has suggested that the developed world should pay \$100 billion a year in total. The European Commission is proposing €100 billion a year in 2020. The gap between the numbers proposed is even larger than those figures suggest, because the Chinese and the Africans seem to be talking about government-to-government transfers only, whereas Mr Brown and the European Commission are talking about a combination of those and private capital.

There is no objective way of establishing how much guilt money the rich world should come up with. The amount of investment needed to clean up the world economy is somewhat easier to determine. According to the International Energy Agency, the 2°C target will require around \$1 trillion a year in investment. The World Bank says around \$475 billion of that total will need to be spent in developing countries.

Various countries have made constructive suggestions about how to rustle up cash. Mexico wants a \$10 billion Green Fund to which countries would contribute on the basis of both their emissions and their GDP; Norway is suggesting an auction of 2% of carbon-market emissions allowances which could raise \$15-25 billion; the poorest countries have proposed a tax on air travel which could raise \$8-25 billion; the World Bank has a \$5 billion target for its climate investment funds. Altogether those might raise \$60 billion, which still leaves a big hole.

How could it be filled? "By private capital," says Cameron Hepburn of Oxford University's Smith School of Enterprise and the Environment. "Rich governments have serious pressures on their finances. But they can maximise the bang for their buck by mobilising their vast capital markets." And private-sector investment is likely to be more efficiently used than government-to-government transfers.

At present there is not much sign of private capital investing in developing-world clean-energy infrastructure. But it is not a mad idea. Energy infrastructure is a long-term investment. That should suit pension and sovereign-wealth funds. With assets of \$12 trillion and \$3.75 trillion respectively, they should be able to raise some of the necessary funds.

But first developing countries need to put in place those "nationally appropriate mitigation actions". In a tiny way that is starting in China, where APG, a Dutch pension fund with a portfolio of \$200 billion, has put together an energy-efficiency fund because the incentives the Chinese government has put in place make it worthwhile. "It washes its face financially," says Rob Lake, head of sustainability at APG.

But China is not short of capital. The problem is elsewhere in the developing world, where economic, political and currency risks scare off foreign investors. So a lot of thinking is going on about how to mitigate those risks. The United Nations Environment Programme, in collaboration with the P8, a group of big pension funds, and other institutional investors, has produced a report on how to use public-sector money to leverage much larger amounts of private-sector finance into clean investment in developing countries; the World Economic Forum has produced another; Lord Stern a third.

The general idea is that the most efficient use for the public-sector funds which rich countries are going to transfer to poor ones would be to insure private money against the risks posed by volatile currencies, unreliable governments and the risk that clean-investment policies will not survive political change. Using public money to leverage private money to build infrastructure and transform economies is not a new idea, says Dominic Waughray of the World Economic Forum: it is the model the Marshall Fund used to rebuild Europe after the second world war. But it is still a contentious one. Some developing-country governments suspect this is a ruse by rich countries to shirk their responsibilities while making money out of the poor. They tend to prefer the idea of the cash going straight into their coffers.

The gaps that remain between rich and poor countries on these issues are huge. It is clear that some will remain after Copenhagen. That does not mean the world is giving up on a deal. It means that there will be a lot of work to do next year. That work will be easier if the world goes about it in a different way.

What needs to change

The prospects are gloomy, but they can be made brighter.



Illustration by M. Morgenstern

THOSE who have had the misfortune to be closely involved in climate-change negotiations are not short of ideas on how the process might be made more productive. One improvement would be to stop trying to deal with so many gases at once (see article). Another would be to stop trying to deal with so many countries.

With 192 participants, the annual UNFCCC conferences are too big to do anything very useful. But most greenhouse-gas emissions are produced by the 17 countries that meet in the Major Economies Forum, a group put together by George Bush in what was widely regarded as an attempt to sabotage the UNFCCC. The MEF has, ironically, turned out to be a good forum for tackling difficult questions. The UNFCCC should therefore stick to big statements of principle and leave the details to the MEF or other small groups.

The negotiations also divide the world into two halves. The idea of “common but differentiated responsibilities” on which the UNFCCC is based—that everybody is in it together but some countries are more responsible than others—is reasonable. But the way it is being applied means that the developed (“Annex 1”) countries bear all the burden of mitigation whereas developing (“non-Annex 1”) countries benefit from the CDM and are not required to limit their emissions at all.

This binary division has fostered an us-and-them attitude that gets in the way of agreement and forces together countries that have little in common. The world economy has changed a lot in 17 years. For example, Mexico and South Korea are non-Annex 1 countries, but also members of the OECD, the club of rich countries. The non-Annex 1 countries now have widely differing concerns. China wants money for cutting industrial emissions. Africa wants generous provisions for forestry. Brazil has hydro power and biofuels, so it wants a regime that favours those. South Africa’s economy is based on coal, so it wants investment in carbon capture and storage.

Most developing countries cling to this division because they have done well out of it, but some middle-income countries are trying to get rid of it. “Mexico’s main goal”, says Mario Molina, a Nobel prize-winning chemist and a key figure in the successful campaign to cut ozone-depleting gases, “is to make a difference in the impasse between developed and developing countries.” Mexico has made a commitment along developed-country lines to halve emissions by 2050, and proposes that prosperous heavy-emitting developing countries—including Mexico—be net contributors to its “Green Fund”. China dislikes the idea, but it is gaining traction.

A further problem with the framework created at Kyoto is that it ignored some crucial sources of emissions—chief among them deforestation, the source of around 12% of man-made greenhouse-gas emissions, more than the EU contributes in total. Dealing with it is also one of the cheapest ways of cutting emissions. But working out how to do that is difficult, which is why deforestation got left out of Kyoto.

Cutting emissions from factories means paying people to do things differently. Stopping deforestation, by contrast, means paying people for not doing something they might otherwise have done. This is tricky. Should people be paid for each year in which they have refrained from cutting down trees? If so, how much? And who, exactly, should be paid? The owners or occupants of forests that are being cut down? Or the owners or occupants of all the forests in the world? That would either be prohibitively expensive, since forests cover 30% of the Earth's landmass, or the payments would not be high enough to protect the most endangered areas of forest.

The UN programme for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD), the main model under discussion at Copenhagen, favours the more limited approach. But that, its opponents argue, would create a perverse incentive. As Bharrat Jagdeo, Guyana's president, says, "You can't have a sustainable strategy that focuses only on those places that have high rates of deforestation, otherwise you'll get leakage. The logging companies will have an incentive to move to countries that have conserved their forests," as Guyana has. Creating a sensible mechanism to deal with deforestation is going to require different levels of payment—higher ones for areas vulnerable to being cut down for farming and lower ones for the rest.

Despite the difficulties, avoiding deforestation is regarded as a crucial tool for cutting emissions. Indonesia, for instance, has said that with REDD in place, it could cut its emissions in two decades by 40% from 2005 levels. A deal on deforestation therefore looks likely—if not at Copenhagen, then in the near future.

Hold the champagne

That the world is gathering in Copenhagen next week to try to decarbonise the global economy is a good thing in itself, and a consequence of other reasons for optimism. It is now widely accepted that averting serious climate change is technically feasible and economically affordable. Everybody has a good idea of what is needed, in terms of money and emissions cuts, to get a deal. Most big emitters have either started on, or promised, serious reduction programmes, and all of those countries' leaders have invested a lot of political capital in being seen to make a success of averting serious climate change.

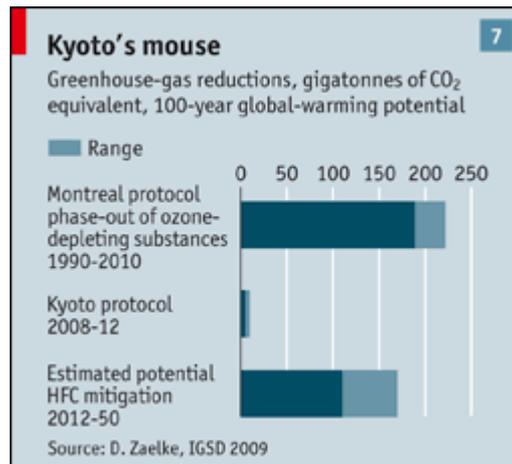
Copenhagen will not produce a detailed, comprehensive, legally binding agreement. But with good luck and good will, something positive may come out of it: a political agreement, which would be turned into a legally binding agreement when the fate of America's climate-change legislation has been decided, and a deal on some specifics, such as forestry.

But even if Copenhagen's participants end up toasting their efforts over the head of the little mermaid, what really matters is how any international agreement is implemented at a national level. And there, although progress has been made, some things are also going awry. Too little effort is going into carbon pricing and too much money into subsidies. The system is getting fat with pork; and the more pork there is, the smaller the chance that the world can cut its emissions without causing serious damage to its economy.

And yet it can be done. Most of the necessary technologies are available. The economics can be made to work. Everything depends, in the end, on the voters and their political leaders. Willing voters and braver politicians will mean better policies. And better policies will enable mankind to make a big difference to the planet's future at a surprisingly small cost.

Unpacking the problem

The attractions of a piecemeal approach to global warming.



ONLY half of man-made global warming comes from CO₂. The rest comes from a variety of sources, including hydrofluorocarbons (HFCs), black carbon (soot), methane and nitrogen compounds. Packing them all up together gives the Kyoto protocol an elegant framework which in theory should solve the problem with a single set of numbers—the national caps that are designed to cut the whole range of greenhouse gases.

Critics point out that the Kyoto protocol has achieved a great deal less than the Montreal protocol, which was designed to prevent the use of ozone-depleting CFCs. Montreal, implemented in 1987, was originally expected to cut half of its gases in 12 years. In the event it got rid of all of them in ten years. It has had a huge global-warming side-benefit. CFCs are greenhouse, as well as ozone-depleting, gases. According to a study in 2007, the Montreal protocol prevented the emission of 189 billion tonnes of CO₂ equivalent. Kyoto has abated around 10 billion tonnes.

Montreal worked better than Kyoto largely because the problem was a manageable size and the gases similar in nature and origin. Some people therefore argue that the greenhouse-gas problem should be unpacked and dealt with under different agreements.

Methane and nitrous oxides produced by agriculture account for about 10% of man-made warming. Most of that comes from the guts of cattle and sheep. That could be cut through breeding programmes and less gassy diets.

Black carbon is a particular problem in the Arctic and the Himalayan glaciers; it melts snow and ice and thus increases the tendency to absorb heat from the sun. It contributes somewhere between an eighth and a quarter of global warming. Unlike CO₂, which stays in the atmosphere for centuries, it disappears within weeks. Cutting emissions would therefore make an instant difference.

Black carbon is produced by diesel engines and primitive stoves burning wood and cow dung. Mechanisms appropriate for dealing with large-scale emissions from power plants and factories will have little impact on peasants' cooking techniques. Providing villagers with cheap, cleaner stoves would be more effective.

HFCs—industrial gases with 1,440 times the global-warming potential of carbon dioxide—are another candidate. Like CFCs, they are produced by a smallish number of industrial processes, and cutting emissions of them is cheap and easy. America, Mexico, Canada and a bunch of other countries have indicated that they support the idea of dealing with HFCs under the Montreal protocol.

Those in favour of a more holistic approach argue that disaggregating greenhouse gases could undermine the effort to solve the problem as a whole. But better to get some significant cuts made than none.

Sources and acknowledgments

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