

Climate Change

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Since the beginning of time Nature has influenced man in profound and remarkable ways. She has provided both the mundane necessities of life, and glorious inspirations for the soul. However this same Nature has also humbled man, time after time, reminding him that his very survival depends upon a partnership with her. The ferocious whims of Nature have often been called Natural Disasters, but a new era has emerged where man's own recklessness may yet lead to an epic Unnatural Disaster.

GLOBAL WARMING

The Earth is like a greenhouse, which lets in lots of energy from the sun but prevents much of it from leaving again. Rather than glass the planet depends on greenhouse gases such as water vapour, carbon dioxide (CO₂), methane and a few others to trap the sun's energy. Historically these gases have trapped just enough heat to make this planet a pleasant and hospitable environment. This delicate balance has recently been disrupted by the release of an ever increasing volume of greenhouse gases, especially CO₂, because man has been burning ever greater quantities of coal, oil and gas.

This shift has already resulted in a small increase in the average world temperature, but the fear is that things could change much more dramatically in the future if current trends are not reversed. The exact details are still fairly debateable as even the most comprehensive climate models find it difficult to model all the interactions of Nature, but it is better to be roughly right than precisely wrong, and the general consensus is that temperatures can and will increase significantly.

The best estimates suggest an average increase in world temperatures of between 1.8 and 5.3 degrees Celsius. Such a change would be devastating to already hot areas of the world, but would also feed through into rising sea levels and more variable conditions worldwide, affecting most nations of the globe. It is also possible to construct several disaster scenarios in which a small change in temperature can be amplified by feedback effects, causing irreversible step changes in conditions. Such

predictions are at once both necessary and dangerous, reminding us of the worst case scenarios but also promoting an unhealthy fear, disbelief or in some ways even an over-reaction.

Regardless of the exact specification of outcomes it is fair to assume that considerable changes in climate will occur, and potentially devastating ones if nothing is done to combat the trend in rising CO₂ emissions.

To deal with the almost inevitable changes which will occur because greenhouse gas emissions cannot be dramatically reduced immediately, it will be necessary to help those who are most affected to deal with the changes. The world's poorest nations will almost certainly be the hardest hit, due to their general geographic location, their reliance on agriculture and their difficulties finding clean and abundant water supplies.

To reduce the likelihood of the severest changes in climate it will, however, be necessary to reduce the volume of greenhouse gas emissions before it is too late. There are many promising ways by which this can be done, including improved efficiency and technology, combined with the tools of taxation and emissions trading, but a political will must make them happen, as idleness will simply make things worse.

EFFICIENCY

The volume of CO₂ released into the atmosphere is strongly influenced by the amount of energy which man generates to power his lifestyle. The use of electricity, heating and transport all contribute to greenhouse gas emission when coal, oil or gas is used.

A simple but effective step in combating climate change is, therefore, to reduce the amount of energy which we use. Mundane but helpful measures include switching off unnecessary appliances rather than leaving them on standby, as many people do

with TVs. Effective insulation will reduce the amount of heating required. The use of telephones and the internet to communicate with people or businesses remotely rather than meeting them in person will cut transportation emissions. All of these measures not only help reduce emissions, they also slash individuals' energy bills, providing a double incentive for them to be implemented.

However these easy reductions are limited in their scope as the vast majority of activities which require energy are absolutely necessary. A more substantial reduction in emissions will emerge from the substitution towards more energy efficient appliances. With developments in technology aimed towards the goal of cutting energy intensity, a new range of products will emerge which will make it possible to maintain our current way of life while cutting energy use at the same time.

Simple items such as energy efficient light bulbs can provide exactly the same benefits as traditional bulbs, at a fraction of the running costs. Hybrid cars can do everything a more traditional car can do but at a much improved miles per gallon ratio. Public transport systems can carry dozens or hundreds of people at significantly lower per person emissions.

All of these measures require more energy efficient substitutes to be in existence, an outcome which will only occur if research and development efforts explicitly include energy intensity as a goal in itself. Many of the new technologies, although they have substantially lower running costs, will require a higher initial investment, so to make them feasible a combination of subsidy and taxation can be used to make them relatively more attractive. These subjects will be discussed in the next sections.

TECHNOLOGY

It is neither feasible nor desirable to cut greenhouse gases by substantially cutting consumption. The size of the reduction would be so great that it would lead to a deep and continual recession, the like of which the world has rarely seen. Falling

incomes, mass unemployment and widespread social upheaval would be a price that few would be willing to pay.

Thankfully the existence of energy efficient technology, and the promising outlook for future breakthroughs, means that it will be possible to cut greenhouse gas emissions while still maintaining the lifestyles to which we have become accustomed. Rather than cutting how much we consume, we can simply slightly alter what we consume, by using the new and better technologies as they become available.

These developments are not, however, inevitable. It must be in the best interests of the private sector companies to invest in these more efficient technologies, which will be so only if there is a demand for these new and modified products. In this both us as individuals, by embracing the new technologies, and governments, by providing appropriate tax relief, can play a part in driving forward innovation in low CO₂ technologies.

Electricity generation

The generation of electricity is the single biggest contributor to CO₂ emissions in the world, responsible for almost 40% of the total. Innovation in consumer appliances will go some way to reducing the demand for energy, but potentially more significant advances can be made in tackling how electricity is supplied.

The worst offender in this area is coal-powered generators. They are widely used as coal has traditionally been very cheap and is abundantly available. The problem is that they are also very dirty, emitting substantially higher greenhouse gases than other available technologies.

A number of alternatives are currently available but each has its own particular drawback. Natural gas has grown in popularity over the past couple of decades as the price of generation has been low while CO₂ emissions are about half what would

be expected from a similar coal-based system. However, as its popularity has grown the price of the natural gas has risen, removing the cost incentive, and there has been growing concerns about its political security as Russia, one of its biggest suppliers, has begun using it as a tool of foreign policy.

Another possibility is the use of nuclear power stations. With zero CO₂ emissions the nuclear option cannot be dismissed without serious consideration. Against this benefit stands formidable problems of high costs, the safety and security of nuclear materials, and the problem of disposing of radioactive waste.

The alternative which is favoured by environmental organisations is the use of renewable energy. Wind, solar and hydro power can be utilised for electricity generation on an ongoing basis without emitting any CO₂. However the cost of such systems remains high, and are unlikely to be able to provide more than a fraction of energy needs in the short term. They also have their own environmental drawbacks as they will often need to be setup in the most scenic areas of natural beauty.

A promising new approach is carbon capture and sequestration whereby CO₂ emissions are reduced by capturing them before they enter the atmosphere. The captured CO₂ can then be stored underground in natural sinks, preventing it from ever contributing to the greenhouse effect. Such a technology could allow coal to still play a part in electricity generation while still achieving the desired reductions in greenhouse gas emissions.

As one of the major contributors to CO₂ emissions the scope for improvements in the electricity generation sector are considerable. For reasons of cost, national security and climate change considerations it is probably preferable that most nations pursue a diversified approach, selecting a mix of technologies. The key is that whatever selection is made, CO₂ emissions are substantially reduced.

Transportation

The transportation industry is also responsible for a substantial share of the world emissions of CO₂. The use of oil to fuel road vehicles and aeroplanes is responsible for almost a third of world emissions, and this figure could grow considerably in the coming decades as developing nations expand. There are already several technologies available which can improve the CO₂ efficiency of engines by reducing the amount of oil required to power them.

Hybrid vehicles improve fuel efficiency by storing energy which is normally lost when cars brake. By improving the miles per gallon ratio, the amount of fuel required to travel a given distance is also reduced, and consequently CO₂ emissions fall as well.

An alternative to oil which is becoming increasingly popular in developing nations is ethanol. This alcohol based fuel can be combined with traditional gasoline to produce a mixture known as E85. Vehicles can have their engines modified to become flex-fuel compatible, at relatively low cost and use this new mixture. Although a higher volume of fuel is required overall, only 15% is made up of fossil fuel based oil, so CO₂ emissions will be reduced. As ethanol is produced from agricultural crops it can be regarded as a renewable energy source which will have economic benefits for farming communities.

Despite these advantages it is unlikely that ethanol will be able to be produced in sufficient quantities to power the world's transport and it would require a massive investment to replace all petrol stations and engines to make them capable of supplying and using the ethanol respectively.

The great hope for the future is that some day hydrogen will be a practical alternative to oil based fuel. When hydrogen reacts with oxygen it releases energy, with the only waste emission being water (H₂O). Hydrogen could be stored in fuel cells and allowed to react with air when energy is required. Although the promise of CO₂ free transportation is seductive, many problems stand in the way.

Firstly, hydrogen is not often found in its natural state in the environment, it must either be released from fossil fuels or separated from oxygen by applying electrolysis to water. Either of these sources require energy to release the hydrogen, meaning that a low CO₂ solution, such as nuclear, renewable or carbon sequestration would be necessary if the goal is to reduce CO₂ emissions.

Secondly, there are concerns about how the hydrogen could be stored and used in vehicles. The fuel cell technology required is currently prohibitively expensive so substantial advances are required before it would be feasible.

Finally, the cost of creating a hydrogen distribution system would be massive. For consumers to buy a hydrogen based car they must be confident they will be able to refuel it no matter where they are, just as they can with petrol or diesel cars. On the other hand distributors will only invest in the distribution system if there is already enough hydrogen based cars on the road to make it profitable, a classic chicken and egg situation.

In conclusion, advances in technology hold the promise of radically reduced CO₂ emissions while maintaining the low cost and flexible solutions which are currently available. However, the long term path of research and development is, almost by definition, unpredictable and surprising. The key is to make CO₂ reduction a primary goal, while allowing flexibility in how this goal will be achieved. For consumers there is little more they can do than assuring the producers that there will be a demand for their environmentally friendly technologies.

TAX

Someone once said that only two things were inevitable, death and taxes. In many areas of life the necessity of raising funds to pay for government expenditure can lead to taxes which discourage activities which benefit society, such as employment

and investment. A tax on carbon, on the other hand, would raise funds by discouraging something which is harmful to society.

Many countries already heavily tax certain sources of carbon dioxide emissions such as vehicle fuel, but few have introduced a systematic approach. A carbon tax would add a certain amount on to the cost of any activity which produced a greenhouse gas. By increasing the cost it should reduce the popularity of that activity, and consequently reduce the amount of CO₂ emitted.

Rather than being seen as adding to the general burden of taxation it would be essential that other taxes were lowered at the same time. If a nation raised \$10 billion via a new carbon tax it would be desirable to reduce, for example, income taxes by \$10 billion so that the overall share of a nation's wealth being taken by the state does not increase.

Such a move would lead to the discouragement of something which is bad (greenhouse gases) and the encouragement of something which is good (employment), and should be both fairer and a stimulus to economic growth.

The idea of an international carbon tax whereby every nation agrees to tax carbon by a certain amount has been floated as a possible way to reduce carbon emissions worldwide. In the search for a widely acceptable alternative after Kyoto, a global carbon tax could be a possibility.

TRADING

Another method of controlling CO₂ emissions is to allocate a certain number of permits to those who are responsible for emissions. A company may be given enough permits to allocate 10,000 tonnes of CO₂/year. If a company can improve its efficiency and reduce its emissions below this amount, say to 9,000 tonnes, it can resell its unused permits at a profit. This gives companies a financial incentive to reduce emissions.

Another company may actually increase its emissions, say to 11,000 tonnes, in which it would have to buy permits from someone else to cover this difference. If it does not buy enough permits it is heavily fined. In this manner producers are encouraged to reduce, or at least not to increase, their output of greenhouse gases.

It also benefits the overall economy as the companies who can reduce emissions most cheaply will do so, and sell the excess to others who cannot. This allows a nation's overall targets to be achieved without imposing binding restraints on each individual company.

The European Union has begun its own Emissions Trading Scheme, which allocates a number of permits to companies in the industries that produce most CO₂. These permits can be bought and sold anywhere in the European Union, and should help the EU to cut emissions more efficiently than by non-tradeable restraints.

Whilst the introduction of an emissions trading system is welcome there are difficulties about its use in practice. Firstly, the total number of permits allocated must be low enough to actually help in the overall reduction of emissions. As the trading system has only recently been introduced the EU has authorised enough permits to make life comfortable for the scheme's participants. This is understandable in the early stages but will need to be addressed once the scheme has been established.

Secondly, once the overall emissions level has been agreed it is necessary to find a fair way to allocate permits between companies. A natural solution would be to auction the permits so that those who need most will buy most, and would mean that the polluter pays. The EU has chosen to give permits away for free, which makes involvement in the scheme more attractive to industry, but raises questions about justice and fairness.

A distribution of permits based on historical emissions would punish those who are already efficient. An allocation based on future projections would reduce incentives to immediately cut emissions. A system based on the industry's best practice may penalise those who for legitimate reasons cannot be as efficient as their competitors.

The trading system can be effective letting market mechanisms influence industry decisions, but until permits are auctioned this cannot be fully achieved.

Two extensions of the Emissions Trading Scheme have also been proposed. The Clean Development Mechanism involves poorer developing nations cutting their emissions, and selling that reduction to wealthier developed nations. This encourages poorer nations to cut their emissions, as they can sell their cuts at a profit, and would allow worldwide emissions to be reduced even if developed nations could not cut emissions within their own borders.

A similar scheme is Joint Implementation which allows developed nations to work on projects in other developed nations to achieve overall reductions in emissions. The key challenge with these mechanisms is how effectively they can be monitored. The potential for fraud and corruption seems to be considerable, and an overly burdensome oversight may be necessary to maintain integrity.

Another example of CO₂ trading can be implemented on a personal individual level. Each of us is responsible for some CO₂ emissions. Rather than trying to abandon the use of energy, which is impossible, we can offset our emissions by financing projects which cut emissions elsewhere.

There are many organisations available which offer this personal carbon trading but the price to offset each tonne of CO₂ varies considerably between them. One of the lowest priced, CarbonFund.org, promises to offset a tonne of our CO₂ emissions for about \$3 by planting trees or encouraging the use of renewable energy. They also

offer a CO₂ calculator to estimate how much CO₂ you are responsible for emitting each year, allowing you to estimate how much you need to offset.

KYOTO PROTOCOL

The problem of climate change was first noticed several decades ago, and since then moves have been made by the international community to address it. The first agreement in 1992 encouraged developed nations to aim to have stabilised their emissions at 1990 levels by the year 2000.

The most significant agreement, known as the Kyoto Protocol, was agreed in 1997, and was more ambitious in its scope. At that meeting it was agreed that emissions should be cut by an average of 5% from 1990 levels by the year 2010. As CO₂ emission levels generally increase with economic growth this suggested an ambitious cut from what levels would expected to have been by 2010.

The burden of this cut was supposed to fall on the major industrialised economies (known as Annex I countries) while poorer non-Annex I countries had no target imposed.

Although signed in 1997 the Kyoto Protocol could not officially come into force until 2005 as it required ratification by countries which together represented at least 55% of global emissions. This was finally achieved when Russia agreed to be involved in the scheme.

The record so far by participants has been mixed. The UK is on course to easily meet its target, largely because the 1990 base level represented a high point in emissions for it. Soon after this point the UK faced a recession and liberalised its power stations, moving from coal to lower carbon gas, both of which naturally reduced CO₂ emissions.

Given this natural advantage the UK has set itself a personal target of a 20% reduction in CO₂ by 2010, and a 50% reduction by 2050, both of which are challenging and the short term target, at least, will almost certainly be missed.

Germany and Eastern Europe will also comfortably meet their Kyoto targets as the fall of Communism brought with it a decline in heavy industry and CO₂ emissions. However most other European nations look likely to miss their targets.

The USA and Australia have remained outside the Kyoto Protocol, suggesting that the burdens of compliance in terms of economic and social costs outweigh the benefits. This is perhaps most surprising for Australia which was actually allowed to increase its emissions by 8% from 1990 levels, while almost everyone else was supposed to cut their emissions.

The share of the blame has, however, been shouldered largely by the USA, and by the Bush administration in particular. Given the inarticulate withdrawal from the Protocol, and a lack of innovation in suggesting alternatives, this is perhaps understandable. In their defence, impartial economic calculations suggest that the vast majority of the cost of Kyoto would have fallen on the USA if they had complied.

However this does not excuse their lack of effort in finding a more feasible solution. Domestically they have encouraged a reduction in CO₂ emissions for every unit of economic growth, but given that the economy has been growing this still implies a rise in overall emissions. Whilst perhaps justly complaining that major developing nations such as China and India have no targets imposed on them, there has been no proposals on what targets could or should be imposed.

The Kyoto Protocol is far from perfect but it does represent a welcome first attempt in addressing greenhouse gas emissions by international agreement. It is only bound

to run until 2012, after which time a new agreement will be required. If it is to find acceptance it will require substantial revision from the original.

POST 2012

The Kyoto Protocol, which runs out in 2012, focussed on achieving specific reductions in the quantity of CO₂ emitted by the world's wealthiest nations. It has only been modestly successful with many of the biggest emitters either not complying with it, such as the USA, or not being covered by it, such as China and India.

Many of those countries which have pledged to enforce it are unlikely to meet their targets. These problems suggest that the successor to Kyoto, running from 2012 onwards, cannot simply be the old Kyoto with newer targets.

The first issue that must be considered is the overall cut in world CO₂ output which is required while still being socially acceptable. Immediate drastic cuts are likely to be extremely costly, and have undesirable economic and political consequences. The cuts will have to be phased in over time, allowing the introduction of newer, more efficient technology, which will be able to make cuts in CO₂ at a fraction of the current economic cost.

The second issue which must be considered is how these CO₂ reduction targets are distributed between different nations. There are questions of natural justice and political acceptability which must be addressed if an agreement is to be achieved.

The Kyoto approach was to ask for absolute reductions, of 5%, from the emission rates of a baseline date, with the year 1990 being used. This approach assumes that everyone can make cuts at the same rates, but this penalises those nations which have had historically low CO₂ emission rates. These low emitters will find it more difficult to find more CO₂ reductions than heavy polluters will.

An approach which would address this issue is to take into account each nation's historical contribution to the greenhouse effect, and penalise the worst offenders. This would mean industrialised nations which have been emitting higher CO₂ levels since the Industrial Revolution would have to cut the most, an outcome which many say is unacceptable as it would give a cost advantage to newly developing nations in economic competition.

Another approach which faces the same counter-argument, is that targets should depend on CO₂ per person within that nation. Heavily industrialised countries generally emit more CO₂ for each of its inhabitants. Developing nations, such as China and India, although big emitters in an absolute sense, are relatively clean when the size of the population is taken into account.

The other topic which needs to be considered is the mechanism by which cuts in CO₂ will be achieved. Kyoto set quantity limits for each nation to achieve. It also created market based trading mechanisms by which heavily polluters could buy permits from low emitters to meet their targets. This scheme focuses on how much CO₂ will be emitted but pays little attention to the economic cost of achieving this. There are also the previously mentioned distribution issues which make it difficult to get an agreement on how much each nation should be expected to cut.

An alternative approach would be to use an international carbon tax, where each tonne of CO₂ emitted will cost polluters a certain amount. This higher cost of emission will encourage reductions in greenhouse gases, and would be fairly transparent and easy to implement. There would, however, be difficulties in setting the rate of tax and questions over whether each nation should set the tax at the same rate due to the distributional issues mentioned above.

Inevitably any agreement which will be reached will be the one that is politically acceptable to all parties, and not that which is necessarily the best overall.

Nevertheless this is better than no agreement at all, so it is imperative that all nations are committed to finding some form of solution.

TAKE ACTION

Climate change is a global issue which can only be remedied by individual responsibility and collective agreement. Each person can play their part in helping to deal with this challenge.

Reduce and substitute

Each of us can begin in our own daily routine by reducing the unnecessary activities which waste energy and so contribute to greenhouse gas emissions. A simple change such as turning off unused appliances like TVs and lighting would be a good start.

New energy efficient alternatives to existing products are being released regularly, and where they are already cost effective they should be seriously considered. By substituting energy-saving light bulbs for traditional alternatives, public transport or hybrid cars for road journeys, or by improving insulation, it is possible to reduce an individual's carbon footprint.

As most of these choices will reduce the energy we consume, they should also save money, even if they have higher upfront costs.

Offset CO₂ emissions

While we can generally make some reduction in our own CO₂ emissions we will never be able to eliminate them completely. Any use of energy, for electricity, heating or transport, is likely to be responsible for the emission of some CO₂.

We can, however, offset these outputs by contributing towards the planting of new trees, the use of renewable energy, or the lowering of someone else's CO₂ emissions. Many organisations allow you to help these projects by paying a small monthly contribution. The cost each organisation charges for offsetting one tonne of CO₂

varies considerably. Carbonfund.org seems to have one of the lowest prices, and it allows you to calculate exactly how much CO₂ you emit by inputting figures on your electricity and heating bills, or your annual vehicle mileage.

Political mandate

Whilst individual responsibility is necessary, it is unlikely to be sufficient to deal with the problems of climate change. The chief responsibility lies with the major contributors to greenhouse gases, the power generation and transportation sectors. Many of these companies are themselves keen to do their bit to lower CO₂ emissions but it is essential that governments provide better incentives and structures so that the goal of greenhouse gas reduction can be achieved.

An effective international agreement is required as a foundation on which others can build. The current Kyoto protocol lacks support from the USA, the biggest emitter, and will run out by 2012 anyway. The successor to Kyoto will have to include not only the major industrialised countries, as the current treaty does, but also the rapidly expanding developing nations such as China and India.

It will then be necessary for governments to implement policies within their own borders to achieve the commitments which have been agreed. A combination of taxation, which imposes higher costs on anything responsible for greenhouse gases, and emissions trading which gives firms flexibility in how targets can be met, are likely to play a part.

It is the responsibility of each citizen to contact their political representatives to encourage such agreement and implementation.

The problem of climate change is real and happening now. If current trends continue an Unnatural Disaster will change the world as we know it, but with a committed response this need not be so.