# TOWARDS A LOWER CARBON FUTURE

*Charles Nicholson and Paul Rutter*

## Introduction

Much has happened since 1988 when the Intergovernmental Panel on Climate Change (IPCC) was jointly established by the World Meteorological Organization and UNEP. There is increasing support for adopting a precautionary approach to climate change. The international process adopted at Rio in 1992 has led to a commitment by the developed nations to develop lower carbon pathways; and the mechanics of co-operation and delivery have progressed through the annual Conference of Parties (COP) meetings to a point of substantive agreement.

There has been a continuing de-coupling of energy intensity from GDP growth, and concerns about energy security and economic waste arising from poor energy efficiency are acting to diversify the energy supply in favor of lower carbon alternatives. This continues a 100-year trend towards lower carbon sources of energy. In 1860 the world was fueled by wood (73%) and coal (27%) whereas today wood has declined to 10% and oil and natural gas have grown to about 60%.

But with demand for primary energy growing at between 2% and 3% a year, the climate issue is inextricably linked with the issues of energy access and secu-

Charles Nicholson is Group Senior Advisor and Paul Rutter is Senior Advisor, Green Operations Technology, BP Corporation.

rity. Governments' concern for the latter can lead to actions that will help mitigate climate change. The energy concern is less a question about the remaining global reserves of fossil fuels but more about local security of supply in regions that currently depend upon energy imports. The oil dependence (net imports as a share of total demand) of OECD countries is expected to grow from 56% in 1996 to 72% in 2010. If no measures are taken, in the next 20 to 30 years the European Union's dependence on imported energy will increase from 50% to 70%, exposing many sectors of the European economy to price instability.

In devising appropriate responses to the climate issue governments are looking to both domestic and international actions. But arguably early certainty on the appropriate policies has given way to a greater recognition of the complexities of finding answers which do not carry an unacceptable economic or social risk, and which will meet with at least a measure of support by those affected. The widespread refusal in Europe to accept ever higher taxes on transport fuels is one example.

With the climate issues now moving clearly to an implementation phase, business and industry are proving to be the principal focus for government initiatives. Many leading businesses have chosen to introduce programs to reduce their emissions of greenhouse gases, principally $CO_2$, and there is a recognition by growing numbers of the need for future action with the likelihood of carbon emissions becoming a real cost of doing business.

But although it is customers' use of products which has the greatest impact on emissions levels, at the consumer level it is difficult to see the advantages of moving to a lower carbon energy supply, particularly when fossil fuels are readily available, relatively clean and cheap. Concern about climate change does not readily translate into changes in personal attitudes to energy use. SUVs, for example,are now the most popular form of personal transport in the U.S.,more and more electrical equipment is left on standby (the equivalent of eight 1000 MW power stations in the U.S. are devoted to providing electricity to equipment that is switched off!) and buildings continue to be 20-30% inefficient in their use of space heating and cooling.

So, in sum the main challenges would seem to be:

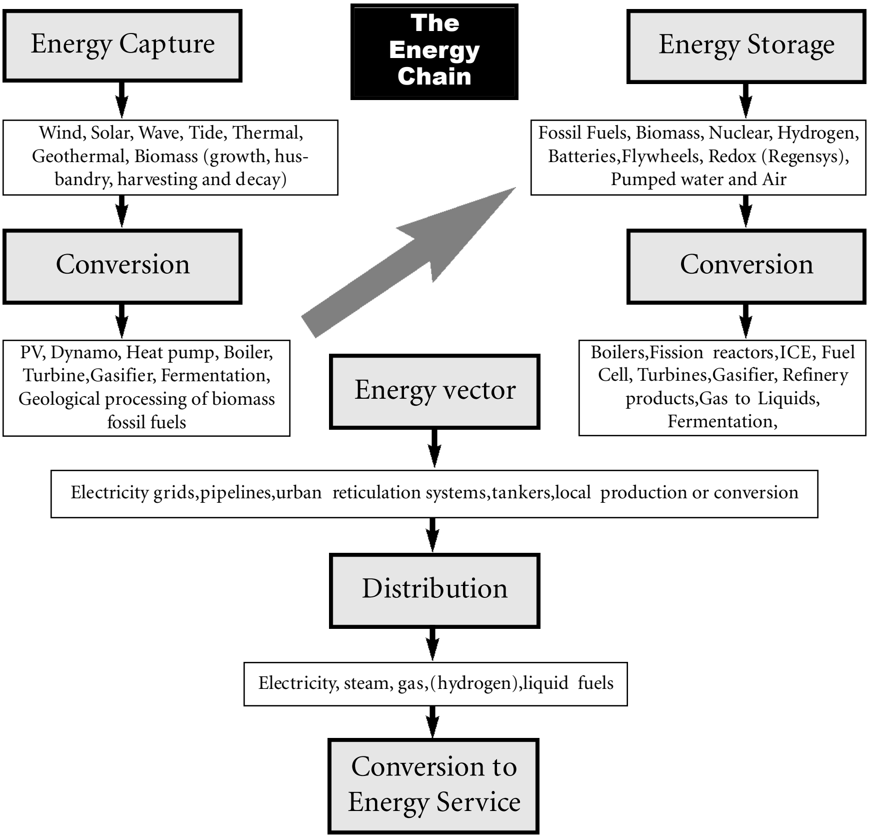
- to devise and implement an energy supply policy which meets the twin objectives of climate mitigation and national security;
- to agree on a suite of policies and measures which facilitate a lower carbon pathway while engaging support and participation from all sectors; and
- to recognize the international dimensions of the issue by pursuing the mechanisms for engaging developing countries in active steps to contribute to climate mitigation.

## Energy Supply Options

It is clear that there has been much change and innovation in the energy field over the last few years. Rates of discovery and recovery have increased dramatically, and natural gas with its lower carbon content has moved to take a growing share of the world's energy demand. And this is in spite of a decade of declining investment in energy R&D in the U.S. (declined by 23% between 1985-98) and Europe (80%). Although Japan actually increased its spending on energy R&D by 1%, it devoted 75% of this to nuclear technology. The energy map now contains many options for capturing energy, conversion, storage and distribution (Figure 1).

The technical feasibility of a wide range of options has led to a large number of scenarios that if implemented would lead to a low carbon future. One of the divisive issues remains the cost or benefit of these. Although costs are highly uncertain, several studies,including those for the low carbon energy scenarios of the IPCC, conclude that stabilization scenarios do not lead to significant declines in GDP growth rates over this century. In a recent study, Anderson *et al* show that the effect of adopting low carbon technologies and practices (including energy efficiency) in the UK would result in about 6 months loss of output growth by 2050.

**FIGURE 1: THE ENERGY CHAIN**




There is no shortage of evidence to suggest the potential for both carbon and cost saving through focus on energy management and the sources of GHG emissions.

In their approach to policy making countries have tended to adopt a range of instruments, taking into account cost, feasibility, capacity to implement, as well as national circumstances and culture. Broadly these fall into regulation, fiscal policies, market based instruments, and processes such as consultation and awareness raising. The role and fit for each is becoming clearer with a recognition that each has a part to play. It is too early to judge their relative effectiveness, but what will be critical are the lessons and experiences that will guide judgement on what programs will best deliver. In Europe at least, the driver is the commitment under Kyoto which, following the agreement at Marrakech, it is now assumed will be ratified.

In political terms the climate change debate appears to have expanded into a more general discussion regarding energy supply security, job creation and sustainable economic growth. While it may be theoretically possible to re-engineer the existing fossil fuel dependent energy infrastructure to both reduce greenhouse gas emissions to achieve stabilization, as well as to satisfy the enormous increase in demand for energy from the developing world, the logistical challenges of this task are colossal. Industry and governments must work hand in hand to demonstrate options, create demand for change and implement innovative financing to overcome the capital cost barriers of moving to the next generation of clean energy technologies.

Although the options for energy supply are increasing and governments are facilitating the implementation of renewable energy, coal is likely to continue to supply 40% of electricity and nuclear around 16%. Moreover in spite of an apparent move towards "clean" energy there appears to be considerable reluctance to implement innovative coal and nuclear technology. The U.S. Department of Energy Vision 21 program is based on coal gasification technology that was first developed in the late 1970s and has been heralded ever since as the future for clean coal, yet only 4-5 coal fired IGCC (integrated gasification combined cycle) plants are currently in commercial operation world wide. Similarly, there are many new designs for generation lll+ and lV nuclear power plants yet new build is almost exclusively restricted to the Far East. Aside from the "dash for gas", appetite for material change in the electricity generation industry is slow to appear.

One way of reducing dependence on energy imports and also reducing $CO_2$ emissions is to focus on energy resource productivity and renewable energy. The cheap price of energy has led to considerable inefficiency in energy generation, transmission and use. The potential for reducing dependence on energy imports through conservation and renewable energy has prompted many governments once again to seek policy measures to stimulate energy efficiency improvements and develop renewable energy generation capacity. The UK recently announced support packages for wind, biomass and solar energy amounting to £100 million. Recent increased support for coal research in the U.S., while increasingly defended in terms of developing "clean energy," is also indicative of the need to retain strategic energy supply and technology.

## UK Domestic Policies

The UK government is searching for policy instruments that will drive greater resource productivity into the economy to sustain growth while protecting the environment. However, improving energy efficiency across all sectors of the economy is difficult. According to the Royal Commission the economic potential for energy efficiency improvement by 2010 across the UK economy is between 12 and 24% . Over the next 20 years the amount of primary energy required for a given level of energy services could be cost-effectively reduced by 25-35% in industrialized countries. And according to a new study ordered by European Commission's environment directorate, the EU could cut greenhouse gas emissions from its households and service industries by some 30% from 1990 levels by 2010. It also reveals that half to two-thirds of the reduction could be achieved at no cost by improving cooling systems and energy performance in buildings.

The temptation for governments is to address the complex issue of reducing demand through taxation. The OECD Environmental Outlook describes simulations that show that a harmonized end to subsidies and the introduction of green taxes could cut $CO_2$ emissions by 15% and methane emissions by 3% over business as usual in 2020. The study assumed taxes on fossil fuels that would rise annually by 2%, 1.6% and 1.2% for coal, oil and gas. The overall impact these measures would have on world GDP would be less than 1%.

The U.S. is certainly not immune from concerns about energy supply and, although adopting a rather traditional approach of securing more reserves from within its national boundary, actions to enhance non-fossil supply and to reduce demand can have a beneficial effect on climate. In a recent analysis ADL estimate that energy efficiency could reduce the growth in U.S. electricity demand from 30% down to 17% over the next 20 years.

## Global Energy Demand

While it is tempting to think that new low carbon energy supply options will be implemented in the near future,inertia and existing capital infrastructure coupled with the enormous demand for low cost energy by the developing countries act as a considerable barrier to a material move away from traditional fossil fuels. Each year aggregate capacity increases in developing countries are about the same as the entire UK capacity, which took 70 years to build. By 2050 China alone may exceed the combined capacity of Europe, the U.S. and Japan – about 1.5 million MW. The required pace of economic growth in the developing world may preclude adoption of low carbon technologies unless greater priority is given to developing and diffusing them. This is particularly true in the case of transport fuels. Transport fuels account for 48% of oil consumption,and there is still considerable potential to improve efficiency and hence reduce $CO_2$ emissions per km though new engine and drive train technology. The European Automotive Manufacturers Association has committed to reduce average $CO_2$ emissions from its new car fleet from 186g/km in 1995 to 140g/km by 2008 with review of a possible 120g/km by 2012. This will contribute 15% of total emissions reductions required by the EU under Kyoto.

The use of biofuels as a blended component has recently been proposed by both the European Commission and the U.S. government as a way of leading to rapid reductions in $CO_2$ emissions. However, there is a great deal of uncertainty surrounding this alternative in terms of actual life cycle emissions reduction and cost. It can also be argued that this is at best a temporary solution since the land and water demands of a significant switch to biofuels for transport would be prohibitive. For example, to offset the $CO_2$ emissions that result from 10% of the 1995 U.S. gasoline consumption using currently available technology would require an area equivalent to 48% of current U.S. cropland.

Hydrogen offers a potential solution to many of the issues surrounding energy storage, clean transport fuels and diversity of supply and is a key feature of many low carbon future scenarios. Vehicle manufacturers and fuel suppliers have developed hydrogen powered cars and buses and are in the process of implementing projects to demonstrate the advantages and practicality of running and fuelling hydrogen powered vehicles in urban environments. Schemes have been proposed to transport hydrogen mixtures (up to 20% volume hydrogen, often referred to as hythane) through existing natural gas infrastructure and to store hydrogen in disused natural gas reservoirs.

The advantages of moving to hydrogen as a clean fuel and energy storage medium are that it can be made in a variety of ways. The cheapest source of hydrogen, at least in the near term,is likely to be synthetic gas derived from natural gas ($3.75/GJ compared to $15.93/GJ from electrolysis). Syngas can be produced from natural gas, coal, oil or biomass and is a precursor of a large range of chemicals and fuels as well as a source of hydrogen.

Hydrogen from syngas cannot be regarded as a "clean" fuel in terms of greenhouse gas emissions,however, unless the $CO_2$ generated in the process is captured and stored. Although several technical options are available,the costs are similar at about $30-50/metric ton of $CO_2$ avoided plus a further $20/ton for transport and storage. These costs are likely to decrease to some extent as technology improves. It is also possible that combined hydrogen and electricity production with carbon capture and storage may increase the competitiveness of coal as a source of hydrogen.

Best available estimates suggest that we will see tens or even hundreds of hydrogen fuel cell vehicles (buses and passenger cars) on the roads of Europe, Japan and the U.S. before the end of 2005. It is claimed that mass production of public transport vehicles will begin before the end of the decade with passenger car production soon after. Toyota claim that they will have a commercial fuel cell available by 2003.

## Policy and Trading

While governments are still searching for the right combination of levers to meet their policy objectives in the climate area, it seems clear that at some point they will need to face the issue of mandatory targets,as business and others need to prepare themselves for the time when carbon has an economic value, and so a real cost or benefit. This underscores the need both to recognize the benefits of treating the issue as a global one, and to experimenting with the means to do so.

While it is not the only solution, carbon emission trading could create a value for carbon that will increase the competitiveness of low carbon technologies with respect to established fossil fuel derived energy. A recent study suggests that the average marginal abatement cost in EU member states with an Annex B-wide trading system would be 32.6 euros ($29). However, commodities must have a value before a market will operate. Since greenhouse gases have no intrinsic value (except in cases where carbon dioxide can be used to enhance oil or coal bed methane production) a value needs to be imposed by governments in the form of penalties that will be incurred for exceeding the level of permitted emissions. Although the issue of compliance is still under discussion, some progress was made in the 2001 Bonn and Marrakech meetings on the implementation of the Kyoto Protocol.

Surprisingly some trades have already taken place in anticipation of a formal agreed carbon emissions market. For example the Australian electricity generation company Macquarie Generation sold 2000 metric tons of emissions savings to Chubu Electric Power of Japan in April; and Edmonton-based Epcor, a Canadian utility company and power producer, purchased 50,000 metric tons of $CO_2$ credits from Finland's Fortum Corporation for US$0.95/ton in January 2001.

The UK-based $CO_2$e.com (Cantor Fitzgerald in association with Price Waterhouse) have a 24-hour Internet marketplace for trading GHG emissions offsets. Trading was around 70 million metric tons in 2000, growing to 100-150 million tons in 2001. Prices are around \$2/ton $CO_2$ equivalent in 2001, rising to \$6-7 in 2012.

In Europe a number of national trading schemes are under discussion or development. In the UK a significant number of companies initiated a project in collaboration with the government to develop a cap and trade system; the first of its kind in Europe,it has taken two and a half years to develop and is due to commence in April, 2002. The government has agreed to offer a 5-year financial incentive through a bidding process for companies who offer a commitment to carbon reduction. The EU Commission has recently issued a blueprint for an EU-wide scheme to start in 2005.

## The International Issue

It is not surprising that reaching agreement on such a complex issue with its implications of rights and obligations should prove so challenging, but perhaps some recognition is in order for the progress which has been achieved. While the framework of Kyoto is not the end game, it does, in the three mechanisms of Emissions Trading, the Combined Development Mechanism and Joint Implementation, provide a framework for reducing the cost of climate mitigation and for engaging the developing countries. The signals of the latter's willingness to participate may be mixed, but their assent to the recent agreement at Marrakech is hopeful.

While domestic policies will be the underpinning of success, those who would ratify Kyoto need to find a route to re-engage with the U.S. Collectively they need to think beyond the 2008-2012 1st Commitment Period under the Kyoto Protocol and prepare for the 2nd Commitment Period and beyond.

## The Role of Business and Industry

Against this background where does industry position itself and what is its contribution? Apart from the obvious fact that there is no unique answer to this, the following observations illustrate the response of the authors' company BP for which,as an energy company, climate change is a strategic issue. But the position and the actions apply to many other companies, and indeed one of the features of the issue is the range of collaborations it has spawned, national and international, within and between sectors, and on technical and policy matters.

As one of the world's largest suppliers of oil and gas, accounting for about 3% of the world's primary energy supply, BP is active in most parts of the "energy chain". Since declaring its target of reducing internal emissions of greenhouse gases by 10% and implementing a focus on carbon management, BP has been acknowledged as a leading player in the climate change debate. We are therefore an active participant and asked to provide practical examples of what can be done commercially to move forward the lower carbon agenda.

The following are some examples of initiatives implemented by BP which recognize both the internal and external dimensions of the issue:

*Carbon Management and Trading*

BP has pioneered carbon trading by implementing a trading scheme between the 160 business units throughout the company. The scheme has been critical to raising awareness and developing focus on innovative solutions. We have learned a number of lessons and now have considerable experience in boundary delineation, banking and credit allocation. BP also leads perhaps the largest carbon capture and storage technology joint industry research and development project currently underway. We are also sponsoring a major research initiative at Princeton, the Carbon Mitigation Institute. We have carried out a number of studies in our operations in the North Sea, Alaska and the U.S. Midwest looking at the possibility of using $CO_2$ captured from flue gas for enhanced oil recovery projects or for enhanced coal bed methane recovery. The study examining the potential for capturing $CO_2$ from the Grangemouth refinery and piping it offshore to the Forties field has created considerable interest in the UK and has prompted a commercial pipeline operator (Kinder Morgan) to examine the commercial possibility of creating a North Sea $CO_2$ and power reticulation system.

The potential business options in the area of carbon management based around the storage capacity in our declining gas fields and oil reservoirs, our technical expertise in handling large volumes of gas, and our experience in all aspects of trading including carbon should make this attractive for BP in the event of the creation of an international carbon market.

*Energy Efficiency in Industry*

Since 1998, in our own operations, we have substantially reduced methane losses through flaring and venting. We have also implemented improvements in energy efficiency resulting in a sustainable reduction in greenhouse gas emissions of 5 million $CO_2$ equivalent metric tons. The capital cost of this program was modest and will return a net present value of $650 million over the next 10 years, demonstrating the "hidden value" in loss recovery energy efficiency improvements. A further 2-3 million metric tons of revenue-positive emissions reduction have been identified and will be implemented over the next two years.

It is clear that more efficient use of energy in the industrial, commercial and domestic sectors could make a substantial difference to greenhouse gas emissions by saving fuel. However, the low cost of energy and distributed customer base have made it very difficult to develop profitable business models in any other than the industrial sector. Our own experience with BP Energy, which provides energy services to the industrial sector, has proved the difficulty of penetrating the commercial and domestic market.

The recent step towards emissions trading created at Marrakech may help, but the material value of improved efficiency will only be seen at the aggregated level rather than the customer level. Innovative business models and/or regulation will be required to unlock the potential added value of energy services in the domestic, commercial and institutional markets.

*Clean Fuels and Transport Efficiency Improvements*

Transport accounts for a significant and growing share of GHG emissions. Despite significant improvements in efficiency overall, that of most automotive drive trains is still only about 20%; consequently a 2% improvement would lead to a 10% reduction in GHG emissions. BP is already working with auto manufacturers to provide the clean fuels required for next generation internal combustion engines and is also actively participating in conjunction with manufacturers of fuel cell powered transport in a number of joint industry demonstration projects designed to develop a hydrogen supply and distribution capability. We have recently created a technology collaboration with the Chinese Academy of Science to develop clean energy technologies including hydrogen.

Given also that consumer emissions are heavily influenced by behavior, there is considerable scope for stimulating customer awareness and responsibility with a focus on changing driver behavior. Some form of reward or incentive would need to be created.

*Renewable Energy*

BP has examined a large number of renewable energy technologies and conclude that solar photovoltaics (PV) and wind have the best fit for the group. Already one of the major players in the solar PV market, BP's plan is to achieve $1 billion in sales by 2007, and we are exploring the potential to use wind generated electricity as a source of power in some of our large operating sites.

The expanding renewable energy industry enables individual countries to capture freely available solar, wind and perhaps wave and tidal energy while at the same time generating jobs in indigenous engineering service companies. The European Wind Energy Association estimate that installing 40 GW of wind energy in Europe by 2010 would create between 190,000 and 320,000 jobs. In particular the growing attraction of biomass as a source of future energy appears to have as much to do with creating jobs in the rural economy as with reducing GHG emissions. Experience from Northern Europe (Denmark, Germany) and Japan shows that creating the right market incentives and stability can stimulate the implementation of renewable energy technology and the growth of manufacturing capability.

*Energy Efficiency in Buildings*

About one third of energy use is in buildings. The grid-connected solar PV business now accounts for nearly 50% of all solar PV and is expected to grow rapidly as the cost decreases. BP Solar is already very active in this area as well as supplying integrated solar PV energy systems for non-grid applications. We are also supporting research programs at Imperial College on next generation organic solar PV and sustainable energy in buildings. The latter program will be closely linked with the Cambridge MIT program on architectural design for sustainable buildings.

## Conclusion

While there are considerable logistical barriers to be overcome in moving to a lower carbon future, technology already exists to substantially reduce greenhouse gas emissions. Deeper cuts in emissions, approaching the 60% believed to be necessary by the second half of the century to stabilize atmospheric $CO_2$ levels at 550 ppm, will require cost effective solutions to energy storage, transmission and $CO_2$ capture and storage. However, the world must demonstrate the will to move towards a low carbon future through the implementation of policies and market-based mechanisms which create incentives to mitigate the cost and risk of implementing low carbon options on the scale required.