Managing the Legacy of Fossil Fuels

By Ronald Oxburgh*

There are still many uncertainties in climate science but although understanding may differ in matters of detail there is general agreement that the accumulation of greenhouse gases in the atmosphere from burning fossil fuels is already leading to changes in climate over and above those changes that occur naturally such as the alternation of ice ages and inter-glacial periods.

For this reason most governments now agree – if with different degrees of commitment – that action has to be taken to curb the emissions from fossil fuels and industrial processes. In spite of this agreement the concentration of $CO_{2,}$ the most important greenhouse gas, in the atmosphere has continued rise over the last fifty years alongside the explosive growth of the world population. Moreover, emissions have grown half as fast again as population. Not only is more fossil fuel being used because there are more people on the planet, but their average per capita energy use is steadily rising as well. To be sure energy sources such as wind, hydro and solar are on the increase, too, but increasing overall energy demand means that their proportion in the energy mix has scarcely changed and they still account for little more than 15% of energy consumed.

When governments or journalists talk about managing emissions they often present the problem as one of not increasing the rate of our emissions and *stabilising* at our present levels. Unfortunately this approach misses the point. If we think of the atmosphere as an enormous filling bathtub and the amount of CO_2 in the atmosphere as the level of the water, *stabilising emissions* means leaving the water taps running at the same rate and continuing to fill the bath. As far as we can tell our bath is at present over half full, and if emissions continue to rise we have only another fifty years or so to avoid catastrophic changes in climate such as breaking down of the Gulf Stream and disruption of the monsoons, not to mention chaotic conditions for world agriculture.

In spite of best efforts to speed the introduction of more renewable energy, not to mention hydro and nuclear, it is clear that at their present rate of growth they will at best simply slightly delay the overflowing of the bath. To have significant impact on the problem the emissions must not be allowed to enter the atmosphere. This means speeding up work on the suite of technologies known as Carbon Capture and Storage (CCS) that trap greenhouse gas emissions at source whether that be a power station, an oil refinery or a cement works. Present practice is to capture the emissions and then transport them – probably by pipeline – to a place where they can be pumped underground and stored in abandoned oil or gas fields or in saline aquifers. To continue the bathtub analogy this is equivalent to easing out the plug from the plughole sufficiently for the water running out to balance the water flowing in. A power station with CCS provides low carbon energy.

All the basic technologies for CCS are well known to the chemical and petroleum engineering industries and combining them as an operating system at an industrial source of CO_2 is perfectly feasible. Unfortunately at the end of 2014, there is, as far as I know, only one power station in the world that has done this and is operating with full CCS. That is the station at Boundary Dam in Saskatchewan, Canada.

The Canadian project was completed with substantial state support. CCS projects in other parts of the world are less advanced but all depend on state support. And therein lies the nub of the problem; at present there is no business case for the private sector to make CCS a high priority and commit to the required heavy investment. The costs of the current technology are substantial not only because of the additional plant needed at the CO_2 source, but also because the gas has to be compressed for transport by pipeline and injection underground, and because a suitable subterranean store has to be developed. The additional energy needed to process the flue gases and to compress them could in the case of a power station amount to increasing the cost of generating electricity by 30%. There is clearly little incentive for any power company to install CCS measures on any of their power plants unless Government deploys one or other of both of the levers at their disposal namely regulation or subsidy. At present there has been too little of either to convince industry to implement CCS with any sense of urgency.

Although the developed world would not welcome CCS costs on the massive scale needed to address the global problem, the costs would probably be manageable, particularly in light of the report of the CCS Cost Reduction Task Force that foresaw significant cost savings as the technology developed. Around 70% of the cost of CCS comes from the present capture process which is both capex

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and opex intensive. A less expensive process is urgently needed to avoid bubbling the flue gases through a solvent that selectively dissolves CO_2 and then heating the solvent to release the gas.

Although the developed world might absorb the additional costs of CCS, the developed world is not where the main challenge lies. At present around half the GHG emissions come from the developed world and half from non-OECD countries and China. Forward projections show the OECD countries emissions dropping slightly while those from other parts of the world increase. By 2030 it is expected that about one third of the emissions will be due to the OECD, one third to China and one third to the others. It is clearly unrealistic to expect countries that have relatively low standards of living and face major immediate problems of health, water supply and food, to give priority to a problem that has its major impact some decades in the future, the more so when the problem was largely generated by more than a century and half of emissions from members of the OECD.

It follows that not only is there an urgent need to implement CCS widely before the bathtub overflows but also to find a way of doing it affordably. One realistic possibility that will be feasible in some places is to use the captured CO_2 for enhanced oil recovery in ageing oil fields. CO_2 is pumped into the field to displace residual oil and enhance its flow. The CO_2 is then retained underground. CCS done this way pays for itself but the opportunities are rather limited.

An alternative approach now receiving attention is to find ways of using the CO_2 to make useful products. At least one business is making money today by taking commercially produced CO_2 and allowing it to react with solids recovered from urban garbage to make carbonate pellets that can be used to make light building blocks. In principle, making solid carbonate building materials is a process that could be widely developed provided there is a plentiful supply of suitable reactants; much natural rock has a suitable composition, but if it has to be crushed to react with the gas the process is not likely to be economic. Other research is focussed on using the CO_2 to make methanol or graphite. Yet other groups are exploring the possibility of using unseparated flue gas directly for some of these reactions. These efforts come under the general name of CO_2 reuse or CO_2 mineralisation.

Whatever efforts are made to reduce our dependence on fossil fuels they (fossil fuels) will be around for decades to come and if the bathtub is not to overflow we must somehow immobilise their emissions. CCS can be applied both to coal and gas although coal should have priority insofar as it produces roughly half as much useful energy as for the same emissions. Immobilisation of emissions will become pervasive rapidly only when CO_2 can be turned into a money-making resource rather than a waste that must be managed. Given that most of the emissions growth is likely to come from developing countries mineralisation of emission gases into building materials would seem particularly appropriate. The volumes of solids produced would be massive.

Without some form of CCS urgently I see no way of preventing the bath from overflowing.