Carbon offsets and sequestration

Carbon offsetting and sequestration have their critics, but in recent years both the Kyoto Protocol and Britain's Royal Society have recognised the potential contribution for rebalancing the carbon equation. With tree-planting now recognised as a significant sequestration option, there are opportunities to link wildland initiatives to major funding sources.

PETER TAYLOR

Offsets and sequestration – the concepts

Carbon offsets are a way by which consumers and businesses can offset some or all of their own emissions of carbon dioxide by funding or purchasing reductions in carbon emissions elsewhere. Sequestration is where emissions are soaked up in the creation of newly forested lands – and this can also be incorporated as 'offsetting'. Pumping carbon dioxide stripped from power station stack-emissions into underground stores such as spent oil fields has also been called sequestration.

Offsets are now established under the EU and Kyoto carbon-trading schemes whereby businesses (at present industrial sector high-energy users) which find it either too costly or impractical to reduce their own emissions, pay for reductions elsewhere. As carbon dioxide circulates globally, it does not matter as far as climate benefits are concerned where the emission reduction takes place.

It remains to be seen how effective industrial sector trading schemes can be in reducing overall emissions at a time when the global economy is expanding and there has been criticism, particularly from environmental NGOs, that offsets may deflect attention from emission reduction at these sources. Such criticism needs to be considered against two factors - a background of general inaction by consumers and the commercial sector with regard to demand reduction (industry, the usual whipping boy has done much better), and the potential wider benefits of sequestering carbon in ecologically sound reforestation.

It is the consumer sector, which is, after all, the driver of industrial demand and in this sector, several private initiatives have developed auditing and 'offset' schemes relating to either buying emission reductions elsewhere or planting trees. In my view there is considerable potential. It is little appreciated how important audits are in raising consciousness, especially when combined with 'clubs' – where a local area establishes a sense of identity, ownership and responsibility (river catchments were used to great effect in waste minimisation schemes). A high profile offset programme in the community may have the knock-on effect through audits of raising consciousness and stimulating demand reduction.

Audits, funds and their disbursement.
The mechanics of carbon offsets work by:

1 A system of self-auditing of annual carbon emissions by discrete entities such as businesses, local authorities or consumer-households. The results are expressed as tonnage of C per annum. An audit can be made by the use of simple conversion tables relating to annual electricity or fossil fuel consumption. It is more difficult to compute 'embodied' energy in material consumption, but access to such data is available.

2 A 'carbon tax' which is either voluntary or imposed is based upon the cost per tonne of abating the total emissions (carbon neutral) or a proportion thereof, as a payment into a funding programme for renewable supply or emission reduction elsewhere. In community schemes household taxes could fund projects in community energy supply or conservation. Schemes can support carbon sequestration in forestry projects. The tariff has to be related to the actual cost of the target abatement technology, for example, a wind turbine or CHP boiler and its annual capacity for carbon reduction, or the cost per tonne of carbon sequestered in forest lands.

Experience with offset schemes

There is little experience with community-level schemes, and carbon trading is only just beginning in the industrial sector driven by government and inter-governmental compulsory tax schemes. Some large companies have used self-taxing schemes to sequester carbon in protected forests outside of their own country. In the private household and business sector, there is experience from two relatively small trust-based private companies – Climate Care and Future Forests, with the former encompassing energy efficient technologies as well as carbon sequestration, and the latter restricted to planting trees to offset the carbon. These programmes have received wide publicity and some criticism relating to transparency and tokenism.

The Climate Care programme of the Carbon Storage Trust has been operating a scheme for several years in the UK, and Future Forests offers a scheme limited to tree planting. In Holland, Dutch electrical utilities have worked with large scale forestry offsets in Africa, and Peugeot in France has set up offset forestry in Brazil.

The Climate Care operation has a well-designed website where generic audits for average consumer households can be computed, and a simple payment system. The website also provides details of the projects funded, which range from provision of low energy light-bulbs in South Africa, efficient woodstoves in Bangladesh, to restoring forests in Uganda.

Audit systems, some web-based, have been developed for various aspects of carbon management and emission awareness as part of an overall energy efficiency strategy of government. For example, the Carbon Trust provides an extensive service of carbon emission audits and advice on carbon emission reductions to local authorities and corporations. So far, about 20 Local Authorities have signed up to carbon management programmes and 10% of the top 350 FTSE companies.

However, it is the consumer/household sector that ultimately drives demand and is largely responsible for the UK's recent rise in carbon emissions – threatening to undermine any current savings in renewable energy supplies.

Generic information on audits for households is readily available: such as average costs and carbon reduction figures for insulation options, lighting and heating, boiler replacement, solar panels, solar PV, micro-CHP, wood-fuel boilers and small scale wind turbines and some of this data would be relevant for smaller scale public buildings and businesses. The audits are relatively straightforward – the consumer can tick a series of boxes regarding average consumption, or enter various multiples and options relating to electricity, gas, car mileage etc. Such schemes rely upon a conscientious household and relatively low cost options, but thus far have made minimal penetration. Community schemes may have greater potential – perhaps in conjunction with gad and electricity utilities.

Community schemes: the potential

Government could seek to engage community organisations and arrange audits for this sector, with the resultant fund managed at a local level and used for schemes within the same community (the Local Support Teams (LST) of the Community Renewables Initaitive are ideally placed). The advantage of a community focus is that households would have a 'club' involvement and greater incentive to reduce their own emissions as well as contribute to community schemes in schools and hospitals.

Whereas audits should provide no problems for local initiatives, especially if there is the potential to work with the Energy Agencies and Carbon Trust, the step that characterises offsets – the setting of a tariff for 1 tonne of carbon emitted, does provide problems of transparency. If a carbon neutral option is to be offered (i.e. the offsetting of all annual emissions – which has advantages of simplicity and potency of the message) or the client is to be given a clear idea of what proportion of their emissions are being offset, then the tariff must relate to:

a) funded projects that are additional to the wide range of projects already under way,

b) projects that meet the costing criteria.

In practice there are difficulties with both of these factors. Some projects may be receiving funds from several sources and other players claiming the offset. In the costing, rates vary from £10 to £1000 per tonne for carbon abatement depending on the type of technology and its scale, and from £10 to £100 per tonne for carbon sequestration in forests, with the cheap end of the scale requiring overseas operations. However, community scale operations and focussing upon certain types of community units such as schools or hospitals may make these issues easier to deal with. For example, replacement of a school boiler by the school 'community' of households is unlikely to involve other claimants for the abatement, and likewise for any planting of trees within the community.

Tree planting problems and challenges

Transparency is a problem for the two main practitioners of offsetting carbon by planting- Climate Care and Future Forests. The latter have concentrated on planting trees, mostly at amenity sites and at high cost, with unrealistically low tariffs - £25 to offset all annual emissions from the average household (6te/annum excluding

motoring). Future Forests have also allowed large corporations to offset small proportions of their emissions, providing 'green' publicity but little real effect.

Carbon sequestration is not popular among environmental groups for this reason, and is seen as a means of avoiding effective action on emissions. Climate Care however, have spread their offset projects among energy saving technologies such as low-energy light-bulbs and efficient wood stoves in the developing world. They have also concentrated carbon sequestration on degraded forest land in Africa in association with the long established FACE Foundation in the Netherlands, which works with Dutch utilities.

Evenso, Climate Care offers household clients a £10/te tariff, and whilst this is about right for low cost overseas carbon sequestration, it is unrealistically low for energy efficiency or renewable sources in the UK (see below for ranges of £50-1000). Furthermore, there is little transparency relating to additionality on the forestry projects, and data on carbon savings from other programmes is not readily available on the website.

Community scale programmes have a potential to avoid these problems firstly by limiting the percentage of offset from sequestration (e.g. 10-20%), and then sharing the planting between cheap overseas schemes on protected but degraded land (policy of the Dutch operations), and a local component that can be split between wood-fuels and wildland in a co-ordinated and integrated approach to local land-use. The latter could access leverage funds for new woodland and DEFRA grants.

Costs per tonne

The cost of offsetting 1 tonne of carbon through renewable supply or energy efficiency varies according to the technology involved. Figures provided by John Willoughby show ranges for small-scale wind of £1000/te at 400W (household size, £1500 installation) falling to £200/te for 75 kW (small business-community, £120K installation) – much larger schemes using 2MW turbines generate even further reductions, but disaggregating costs is less easy as large subsidies are involved. Other supply technologies, both of supply and efficiency options, cannot match these costs, and are likely to be 5-10 times more expensive.

A more detailed appraisal of the range of costs per tonne of carbon is required – particularly the difference between marginal extra costs at replacement and the costs of retrofitting. For example, using domestic scale wood-fuel boilers (£4000 cost) gives a cost of £100/te for retrofitting. Community buildings, school, University and hospital sized installations would come in below that figure as they can make use of economies of scale, but at higher initial capital outlay. Domestic-scale solar hot water is expensive at £600/te and PV at £1200/te – although with some economies of scale expected for larger installations.

There is a great advantage in having households involved in raising the funds for their own community projects. Several thousand households could subscribe to a club on an annual basis and enable an LST to facilitate a community bank able to borrow money for larger capital projects amortised over several years. There are educational

spin-offs as well as the potential for demand reduction that arises from awareness and the presence of a 'club' and 'catchment' area that fosters responsible action.

However, in raising money from households, tariffs have to be set at realistic targets for household energy budgets (perhaps a maximum of 10% of annual costs) and thus £10 per tonne is probably the maximum feasible. This would bring in £60/annum for an average household's space heating, lighting, appliances and hot water.

Once audits have been completed and suitable costs/tonne adopted, projects would then be required that:

a) meet the cost criteria

b) could be shown to be additional to programmes of carbon emission reduction – i.e. that they would not have happened otherwise, and that the offsetting is not also being claimed as part of another scheme.

Ideally, projects would use a defined mature technology that provides some transparency, is located in the communities where the money is raised, and has some 'visibility'. In this respect, householders could be part of the community that undergoes audit and raises funds, especially if they have a close relationship to the projects where the money would be spent – for example, parent-households with the local community school, community hospitals, swimming pools etc.

In the case of gas, oil and electricity use there would be a potential for involving the suppliers in sponsoring the costs of audit packages, as well as distribution of material to households, data collection and support facilities. However, I would favour a hybrid scheme whereby the suppliers at least match the household contribution.

It is likely that in any one area, the take up of these schemes will not generate large sums of money and so the choice of technologies should focus upon relatively low capital expenditures – especially of a kind that could be deployed in school buildings (and other community venues, such as village halls, swimming pools etc). The options that suggest themselves are:

- small-scale CHP
- wood-fuel boilers
- replacement of lighting
- window glazing
- biodiesel conversion for community transport

The domestic sector costs of these technologies show figures of around £100-200/te and more research is therefore needed to show what economies of scale would exist for larger projects in schools and other public buildings. A figure of £50/te is more realistic for UK operations at the community scale – a household offsetting 50% would contribute £150/year, which is substantial and affordable only in relatively wealthy communities.

There will be some educational value in showing the true cost of small-scale community-friendly projects and why large environmentally damaging schemes are

preferred by government and corporate interests (which now includes some very corporate environmental organisations). This might lead to a greater incentive for households to invest in their own demand reduction (especially lifestyle changes) – each household could be provided with detailed costs of retrofitting options, marginal extra costs, sources, grants etc. as part of the programme of raising community awareness.

Community-schools project

The advantage of a parents-schools-local businesses community-based scheme would extend to the educational value of becoming involved, particularly a realisation of the costs, economies of scale, and pressures acting to generate non-community based schemes in the countryside such as large wind turbines, larger biomass stations and tidal barrages.

However, once a scheme was set up a Local Support Team would then need to operate a bidding system for the funds and the bidders would be required to meet the cost per tonne as well as additionality criteria. Capital schemes would need to show carbon savings over the expected lifetime of the installation, as well as initial costs, running costs and decommissioning. Access to low cost loans would be of benefit, as well as 'leverage funds'.

There is much to recommend a community loop – where parental households raise money for the local school. A standard educational package could be prepared for schools that pupils could then take to their household, and schools could also receive advice on emission reduction options, with pupils also involved in auditing the schools energy use, losses and supply technology. Liaison with local businesses and audit procedures could also involve students in the learning of business accounting, communication skills and computing.

Carbon sequestration and conservation

There is much to be said for linking carbon emissions and offsets to the role of forests as carbon sinks – and great potential for there use in community and consumer schemes. Critics have tended to focus upon the temporary nature of the sink, and on possible distractions from the over-riding imperative to reduce emissions rather than compensate for them. Such criticisms have been answered in a major recent review for the Royal Society[1] which argues the value of *market-based* approaches to carbon sequestration – more particularly through the mechanisms of the Kyoto Protocol. The review team provide a challenging introduction for anyone drawn from the NGO sector, most of which have campaigned (irrationally in their view) against such 'market-based' solutions, and even against the very principle of allowing carbon sequestration to be used alongside emission reduction within the Protocol. One does not have to look far for unconscious motivations: NGOs are now dependent upon a large membership of consumers unable to face the real issue and who fund their denial with token offering to green causes. How far NGO opposition led to the neutering of carbon sequestration mechanisms is hard to tell – there were other forces at work, not the least an aversion on Contracting Parties to letting the USA off the hook because of its purportedly vast carbon sequestration resource in ecologically recent cut-over forest lands.

However, the principle is now accepted under the Kyoto Protocol, and has recently been promoted by the Royal Society.[2] The temporary nature of the sink is not a valid criticism – new forested land in Britain can accumulate carbon at 2 teC/ha for over 100 years and in that time provides an immediate policy response. In that longer term other technologies, such as hydrogen fuel, as well as lifestyle changes and eco-industrial restructuring have time to mature. Furthermore, under the best schemes such a programme would run in parallel with energy efficiency and renewable options.

In the case of community offset projects such as schools, a proportion of the fund, perhaps 10% could be channelled into appropriate forestry schemes in this country and overseas. Supporting land purchases in the voluntary sector (e.g. Woodland Trust) provides a secure and more transparent option than high-cost amenity planting and could be carried out in partnership with the local Wildlife Trust in the purchase of farmland adjacent to woodland nature reserves. Only marginal land is likely to meet the cost criteria but leverage funds for woodland planting and care would be readily available. As an example-

- 100ha sequester 2te C/ha/year for 100 years = 20,000 te C at a cost per tonne of £10 at £2000/ha, and £20 at £4000 ha. (Planting costs can be met by other sources)
- This compares with 2x75 kW wind turbines (ca £200,000) with a life of 20 years saving 2000 te and costing £100/te.

Such an initiative would also act as an educational tool on the carbon cycle and the loss of carbon due to agricultural land uses and link children and schools with local nature reserves as well as the global commons. A division of the carbon sequestration fund between local and overseas projects would have a greater educational value relating to the global nature of the carbon cycle. The sequestration fund itself could be a percentage of the overall fund, although land costs are high and it might take several years before significant funds could be raised.

The international dimension

After 10 years of the Climate Convention, and with clear recognition that 20% of carbon emissions come from tropical forest destruction, there is still no global financial mechanism that will provide any incentive on the part of developing nations to protect their forests as a carbon sink (even mature forests can sequester extra carbon) – and our own narrowly-focussed campaign groups that include Greenpeace, FOE and WWF may be partly to blame. The most that Kyoto allows – and that was decided only in 2001, is for reforestation projects to gain carbon credits.

However, the World Bank has been piloting schemes using a Prototype Carbon Fund to test out ideas for forest protection that are not yet supported by Kyoto and which would also promote sustainable economic development for forest peoples. Such schemes can also be extended to include carbon-friendly sustainable agriculture as well as energy crops. Over the last ten years, $2.7 billion has been spent on these

schemes within the Global Environment Fund. This is at least an order of magnitude below what is needed to make a significant impact. The global potential has been estimated at 1.6 billion tonnes could be sequestered over ten years in simply preventing forest destruction (running at 16 million hectares/year) *and* allowing those forests to sequester additional carbon, with a current market value of $10/te. This would yield $16 billion dollars – money that could go to the grass-root, impoverished communities that currently drive forest destruction. Similar calculations show 0.4 billion tonnes for sustainable agricultural practices and 0.3 billion tonnes for forest regeneration. Sixty percent of this money would go to South America, 27% to Asia and 12% to Africa (see Swingland).

Even assuming that money can be used with all the effective safeguards, the data show $20 billion is required over ten years to support forest protection, regeneration of badlands and sustainable agriculture. This sum is small in terms of national budgets: consumers in the UK's domestic sector for gas and electricity, at 20 million homes, could, if they contributed 10% of their annual bill, fund the whole global programme!

The consumer conundrum

Governments and inter-governmental agreements are not likely, however, to embrace taxing the consumer – with the household sector already suffering rising fuel bills, and the banks keeping a wary eye on inflation. Any movement is likely to remain voluntary. This runs counter to natural justice – as the conscientious increase their costs and lower their disposable incomes whilst other polluters take advantage of their freedom. One possible solution would be for utilities to emulate AES and offer a surcharge as a way of competing in the 'green' supplier marketplace.

In such schemes there would be a potential direct link between all consumers and the carbon sinks - which in a good scheme, will be either natural forest regrowth on degraded land (FACE in the Netherlands has restored 300,000 ha in African National Parks) or woodfuel plantations coupled to natural remnant forest protection and expansion (AES in Central America). Climate Care in the UK buys into the FACE programme. Such voluntary self taxing schemes now operate across the industrial sector (power companies, car companies, household electricity suppliers etc). The crucial question is whether or not the consumer conscience and industrial green credit is bought by tokenism or by genuine carbon neutrality where the full whack is paid.

There is no doubt a certain amount of opportunistic tokenism in the work of Future Forests – an organisation that has allowed green credentials to be claimed irrespective of audits and transparency. Climate Care have done their best to respond to criticism - they not only plant trees and pay for ecological restoration in the tropics, they also invest in energy saving devices such as improved wood stoves and lighting (in Africa) - but again, there is little transparency regarding the actual carbon savings per unit cost. FACE is more transparent as is AES and have really made a difference. Some big companies - e.g. Peugeot in the Amazon have insitigated large schemes but without the transparent relation to company audits.

Ecological restoration and meaningful amounts

However, one of the greatest benefits of 'tree planting' as ecological restoration is its potential to alter the development agenda both in the UK and Africa (and other tropical countries). How much money is currently available for ecological restoration in the UK and in African aid? My guess is that for the UK if you added up all the Woodland Trust, NTS, Wildlife Trust and RSPB joint HLF habitat schemes that might qualify as ecological restoration - the figure would come to around £50 million per annum, and one might get another £30M from forestry commission/woodland grant projects - maybe £100M in total. I doubt that out of the several £billion in UK aid programmes to Africa there would be much more than that figure for ecological restoration.

A carbon-sequestration-coupled to eco-restoration tax at 10% of household electricity and gas bills would yield £1 billion. Another 10% on road-fuel would yield £2.6 billion. Another 10% on airline tickets - maybe £500m? Annually! We do not have figures for how many hectares could be restored in the tropics and how much carbon sequestered for that money - but if £10/te is the right order of magnitude, then we are looking at an annual committed absorption of two or three hundred million tonnes of carbon – ample to offset the UK's current emissions.

Starting in our own backyard

If a proportion of funds were directed to ecological restoration in the UK using either land purchase or employing farmers as carbon conservers – a 5000 ha lowland restoration project of fen woodland and peat regeneration (e.g. Cambridgeshire fens) costing £5000/ha with minimal running costs and a capital outlay of £25 million, would lock up close to 1 million tonnes over 100 years at £25/tonne.

Just such a sum has recently been allocated by DTI just for the *research* into sequestering carbon dioxide stack-emissions in disused oil-wells, showing how much easier it is to get large sums of money for unproven technology compared to simple, expandable and proven ecological methods.

In the uplands of Britain there are at least 500,000 ha of ecologically degraded low-carbon acid grasslands that are currently under subsidised sheep production, earning farmers an income below subsistence levels (recently as low as £4000/annum/worker net income). The CAP subsidy just balances production costs. Most of these workers are family men eligible for income support. Thus, governments currently carry this cost.

I would estimate the total current cost to the taxpayer of the order of £100/ha with 5000-10,000 direct jobs, and perhaps twice that in the rural employment chain. In the last seven years, UK manufacturing has shed 1 million jobs, all of which have been re-absorbed in other sectors – so it is hardly a major policy shift to radically restructure this sector, and one which CAP/GATT reform may ultimately demand.

Government could readily support a 100 sq km pilot scheme (in the Rhinogs for example where I would estimate 200 stakeholders). If land were not bought but farmers employed as carbon conservers at £20,000/annum, the cost would be a minute £4M/annum! If these figures can be extrapolated to the 500,000 ha of the Scottish, Lake District, Pennine, Cambrian and Dartmoor degraded species-poor grasslands,

then £200M/year – or less than 10% of the tax-yields we have mooted, would transform the British uplands and the whole 'conservation' agenda of wildland, allowing space for wild herbivores and some of their predators, as well as doubling rural incomes

Purchase appears a cheaper option and more appropriate in Scotland where there are fewer jobs on the land. Mar Lodge's 30,000ha cost under £10M, and thus the Affric Core Area scheme's 1000 sq km might cost under £50 million to purchase. The politically more acceptable option of maintaining employment as carbon conservers (with compatible wildland enterprises in eco-tourism) would certainly be a lot cheaper per unit area than the Welsh option

On these ball-park figures, we have a range of prices of £25/te C for land purchase if the credit is taken to 100 years in purchase agreements, rising to £50/te for half that credit period. If farmers and estate workers are employed as carbon conservers and their incomes doubled as incentive to change, then 100 year costs come out at £100/te and half that for a 50 year period (after which some scheme would be required to maintain the maturing forests and prevent the carbon returning). The total investment for the UK's 500,000 ha of new wildwood in the purchase option is £2.5 billion, or one year's 10% carbon fuel tax in the consumer sector. The cost doubles to £5 billion over 50 years in the land-lease/employment option, or £10 billion over 100 years, with the advantage of pumping money into rural communities at the grass-roots instead of into a smaller number of landowners.

In terms of costs per tonne, these figures are much lower than the whole range of domestic sector costs (new efficient boilers, insulation, solar panels, photovoltaics) which range between £100-£1000 per tonne), and close to the figures for smaller scale community renewables – and are perhaps undercut only by large wind turbines (though I would like to see figures with subsidies taken into account) and nuclear stations, which in any case have limits to their contributions to the energy supply mix over a 50 or 100 year time-span.

Conclusions

Carbon offsets may have great potential via community building (developing skills, confidence and relationships) to increase consciousness and stimulate change. Funds raised may be small at first, but a few projects are all that is required to gain publicity. There is great potential for commercial sponsors and production of educational material. The greatest potential probably lies in linking schools carbon use to parental households and the Local Support Teams. If every school in Britain operated such a club, then as was found with other relatively small-scale non-glamorous changes, the summary effect can be substantial. If this were linked with carbon sequestration in the extension of wildland both close to communities, and in a broader national strategy, as well as overseas grass-roots aid programmes of ecological restoration, there might be considerably more take up of voluntary schemes or public acceptance of government taxation.

References

1 Swingland I.R. Ed (2003) *Capturing carbon and conserving biodiversity: the market approach,* Earthscan, London.

2 Royal Society (2001) *The role of land carbon sinks in mitigating global climate change.* London.

Peter Taylor directs the ecological consultancy Ethos-UK.