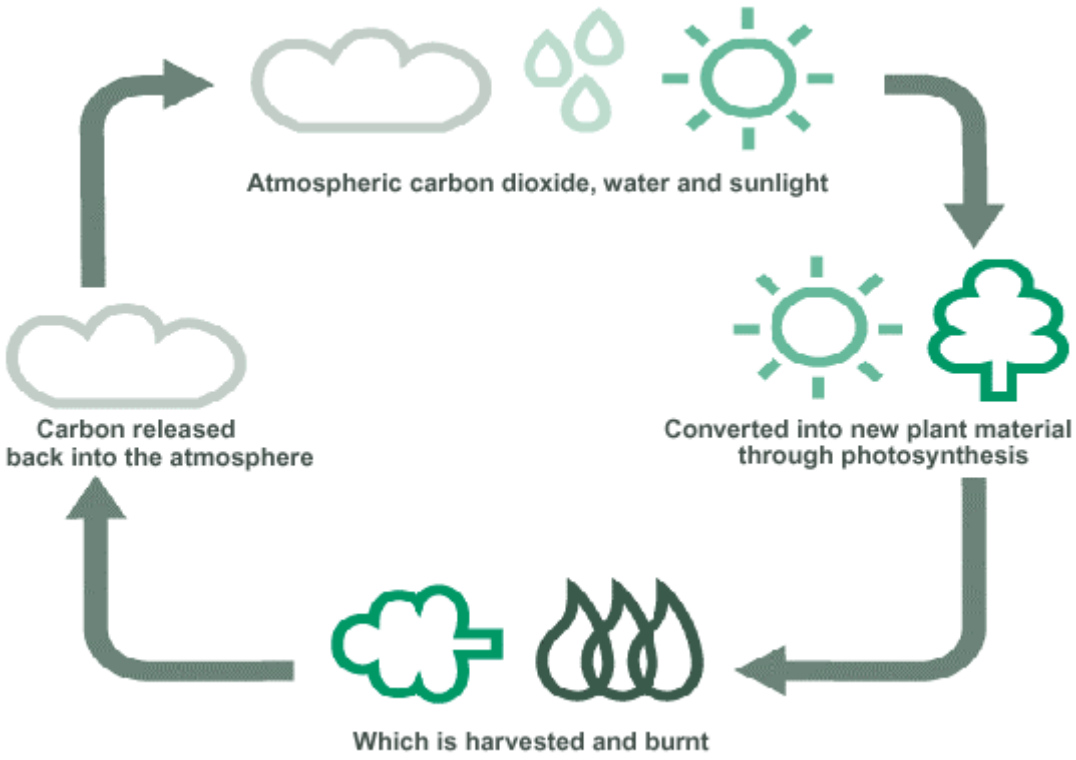
Woolhope Dome Community Woodfuel - a note on carbon

Jon Halle, Glyn Edwards May 2011

A number of people have questioned the real carbon benefit of the project. This is very welcome – it is only through open and honest debate that we will get past claim and counter-claim to real solutions. This summary explores the theory of low-carbon biomass, how this interacts with woodland management issues, and examines a well-known recent paper which questions the low-carbon credentials of biomass

Why is biomass a renewable and low carbon source of fuel?

The sun is the primary source of energy contained within all biomass fuels – its energy is captured and stored via the process of photosynthesis. This energy can be released and used (e.g. by combustion). When this occurs, CO_2 and other by-products of combustion are also released. However, the CO_2 released is largely offset by that which was absorbed in the original growth of the biomass, or which will be captured in the growth of new biomass to replace the biomass being used



Consequently biomass is considered to be a low carbon technology if the material is derived from sustainable sources. In contrast, when fossil fuels are combusted, they release CO_2 that was captured by photosynthesis millions of years ago, and it is the release of this 'fossil' CO_2, as opposed to contemporary 'biogenic' CO_2, that is the major contributor to global climate change. Although

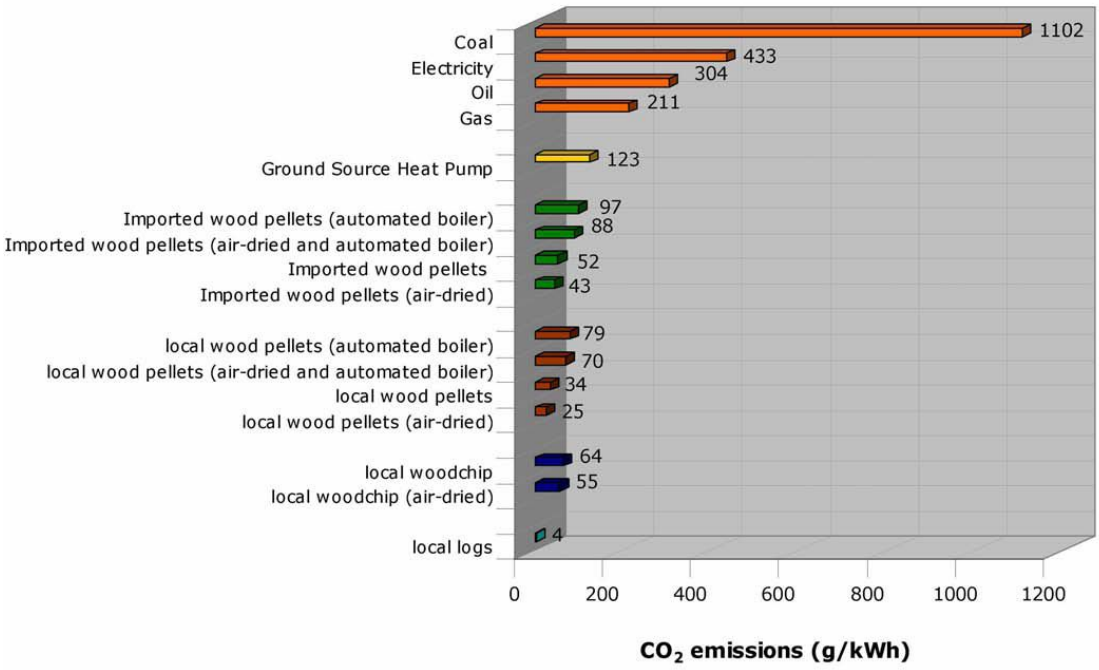
the CO_2 resulting from the combustion of biomass can be recaptured by the new growth of sustainable biomass, some net emissions still result from the cultivation, harvesting, processing and transportation of the fuel, and the manufacture and operation of the necessary equipment (e.g. the biomass plant). These processes consume fossil fuels and thus lead to some CO_2 emissions.

For estimates of CO_2 emissions from processing and transport of woodfuels see the summary in article below

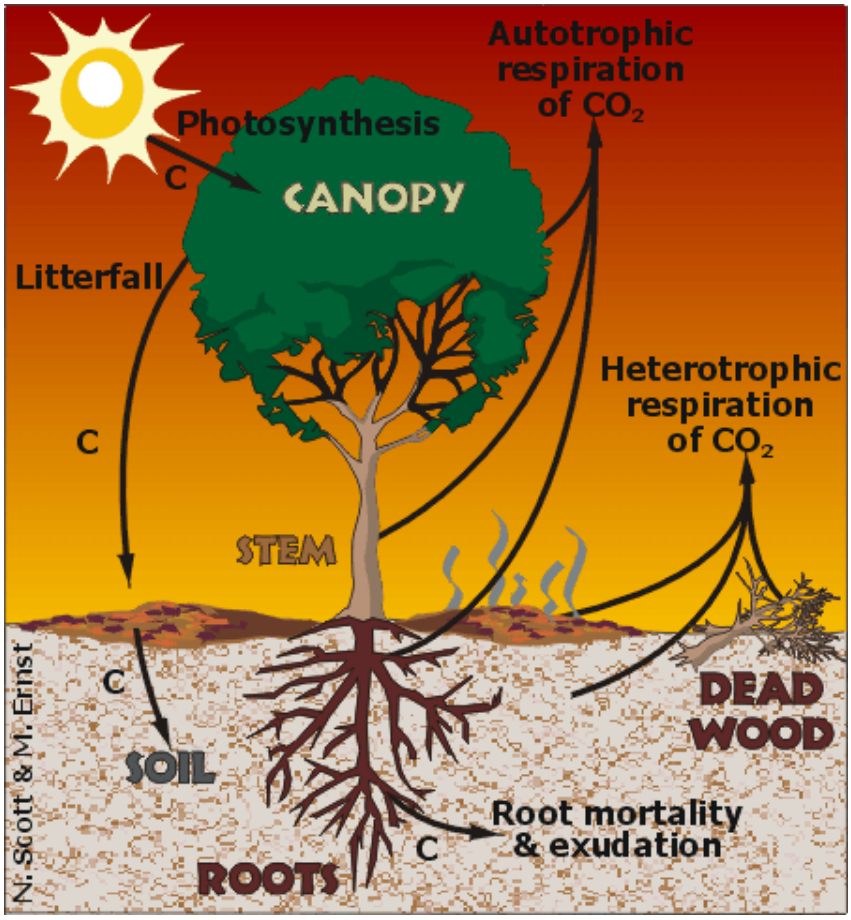
http://www.highlandbirchwoods.co.uk/UserFiles/File/publications/Woodfuel/carbon balance report.pdf

A figure from the same report illustrates that replacing fossil fuel use with biomass can result in very significant CO_2 reduction.

In this project we are largely replacing electricity and oil (near the top of the chart) with local air-dried woodchip (near the bottom) –a sixfold reduction in net CO_2 emissions.



Carbon in unmanaged woodland



There is very little long term net fixation of CO_2 from pristine unmanaged forests because the system has reached "steady state" where the rate of CO_2 fixed by photosynthesis taken up from the atmosphere is almost in balance with the rate of release by the trees via (autotrophic) respiration and via the rotting of dead materials by micro-organisms (heterotrophic respiration).

The only way to increase net fixation of older forest is to remove material (e.g.) and prevent it rotting. Also, removal of such material also creates space and allows young trees to grow rapidly and as such increases CO_2 fixation such forests to become a net CO_2 "sink".

Less than 1 % of Englands forests are primeval: The vast majority of broadleaf woodland forests such as those on Woolhope Dome have been managed by coppicing for the production of firewood over the past thousand years. Management of such woodland went into rapid decline as coal became available in the 19th Century and virtually ceased by the early 1940s. As such, many of the forest have become more mature. The growth rate of trees slows as they age and the amount of rotting increases. As such and the rate of net fixation of CO_2 has significantly declined as the woodlands mature and approach "steady state".

Because the woodlands are unmanaged, no material (wood) is removed from such woodlands to reduce CO_2 emissions from rotting.

How does management affect the amount of carbon a woodland sequesters?

The amount of carbon that can be sequestered and retained on a particular site will vary depending upon the management of the site:

Woodland planted and all trees retained: If a woodland is created and no timber removed, then the carbon sequestered on that site increases quickly for a number of years, and once the woodland becomes mature (50-100's of years depending on species) the carbon retained on the site remains roughly static, with increases from sequestration balanced by decreases from emissions – from decaying dead trees, litter and from the soil. This long-term average (over 100's of years) amount of carbon is the maximum amount that can be claimed from such a woodland (see Figure 4 in FCIN48).

Woodland planted and some trees extracted for timber: If a woodland is managed and timber is extracted from the woodland, then some of the carbon is effectively removed from the site and sold, within the timber, on to another owner. The clearest example of this is if the site is managed on a clear-fell regime. In this case, the woodland would grow and sequester carbon for say 50 years, but then the entire above-ground timber (and carbon) stock would be removed and sold to a different owner. The woodland would then be replanted and grow again. In this case, it is harder to see how much carbon is stored on the site in the long-run as it varies from zero to a maximum each 50 years, each time returning to zero. The long-term average (over 100's of years or many rotations) is the maximum about of carbon that can be claimed from such a woodland. The long-term average tends to be around 30% to 50% of the maximum amount of carbon on the site in any one rotation, depending upon species and rotation length.

For much more on management and carbon see:

http://www.forestry.gov.uk/pdf/fcin048.pdf

Why is reducing fossil fuel use so important?

It does not make sense to look at carbon sequestration separate from fossil fuel use. Concentrating on locking up carbon in the soil and eventually in rocks is indeed a valid strategy but would only work on its own if we had many millennia over which to act. It has indeed been happening over many millions of years. At the end of the Cretaceous period 65 million years ago, average CO_2 levels were about 1000 ppm instead of the pre-industrial levels of 280 ppm. Unfortunately, human activities release geologically fixed CO_2 many hundred of times faster than CO_2 is fixed into the ground by natural processes and human activities over a few centuries have the potential to reverse a process that's taken 65million

years unless we act now. Therefore we need to focus on stemming the tide of geological carbon release as the first priority. The use of biomass as a substitute for fossil fuel can help in alleviating this situation provided that it is done responsibly and sustainably.

Recent challenges

In September 2010 the Association for Environmentally Conscious Building published a paper 'Biomass: A Burning Issue' [1]. This paper has become a focus for attacks on biomass and essentially points out two things:

1. In practice, burning biomass and growing it are separate activities, so it is not right to claim biomass burning as an inherently low-carbon activity.
2. Growing wood and either letting it keep growing or using it in building locks up carbon.

I think that both are largely justifiable observations, and they are made against a context where biomass is being put forward as a silver bullet by people wanting to sell boilers or get out of designing buildings properly, and a counterblast was timely.

However the paper has been part of a rather simplistic reaction against all biomass – the authors quote David Olivier

> Biomass boilers are an expensive way to make climate change worse and reverse over a century of public health improvements

For us working on the Woolhope project (and indeed anybody working seriously on biomass rather than just selling some boiler gear, trying to cut corners on building design, or out for a quick buck) this is frustrating . We are very aware of the need for a project to deliver a net carbon reduction and we naturally take production into account. In practice this means the fuel we use needs to be the result of enhanced woodland management. In other words, matching the points above:

1. Our scheme aims to link growing and burning very tightly. Woodfuel sourcing is as important a part of the plan as boiler fuelling , and it is right to look at the overall scheme, not just the boilers, when assessing our overall impact

2. We are taking low productivity woodland and providing an incentive for it to be managed for high productivity. Much more wood is produced under the scheme than would be the case otherwise.

Lets have a high-level view of the carbon inputs and outputs, starting at the emissions end.

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[1] http://www.aecb.net/UserFiles/File/Biomass_A_Burning_Issue_September_2010.pdf

Emissions at the Flue

It's quite right to say that a biomass boiler does not necessarily produce lower emissions at the point of use than an oil boiler (which is what we are replacing in many cases). In fact, we are replacing old oil boilers with new, efficient woodchip boilers which will be professionally maintained so that in many cases we may be reducing flue emissions, but it is not the primary basis for the project's claim to be genuinely carbon-reducing.

Emissions from the Fuel

The place we really make a carbon reduction is in the fuel. Instead of oil, we will be using woodchip sourced from local woodland. Of course that woodland already grows some wood and we don't want to count that carbon takeup twice. However the focus of the project is to bring unmanaged or undermanaged woodland into management for woodfuel. Better management means better productivity, more wood and more carbon takeup: we can therefore take fuel out without reducing the net capacity of the woodland to sequester carbon.

Of course in theory you could manage a woodland for high productivity and then sequester that extra carbon in the soil, and this is in essence what the authors of the paper propose. This would indeed decrease net carbon emissions, but it is utopian. Woodland management is very labour intensive. Who pays for this? In the case of managing for fuelwood, you sell the fuel. In the case of managing for carbon, who is buying, right here and now? One can also manage for construction wood: sure. Woodland owners know this, and have done for millennia, hence 'coppice with standards': fuel and poles plus big slow-growing timber. But again, a marginal proposition: which is why so much woodland is not managed in this way. Our project provides a real incentive to increase woodland productivity – which has benefits for wildlife and biodiversity (which is why conservation volunteers spend a lot of their time coppicing!)

Conclusion

Those of us who are familiar with energy issues recognise a place we have been many times, where somebody remembers to remind us that:

- There are no silver bullet solutions
- Government policy and incentives are often perverse
- Some 'low carbon' projects are pure greenwash

Every time these truths are brought forward, it's tempting to completely discredit the technology in question: biodiesel, heat pumps, onshore wind, whatever. But in reality it's not the technology itself that matters so much as the implementation. Woolhope Dome Community Woodfuel is designed as a model for sustainable, ethical implementation of biomass heating. This model will not work everywhere, at every scale and with every type of boiler user and woodland. But we strongly believe that in this case it will be both financially robust and genuinely low-carbon.