The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

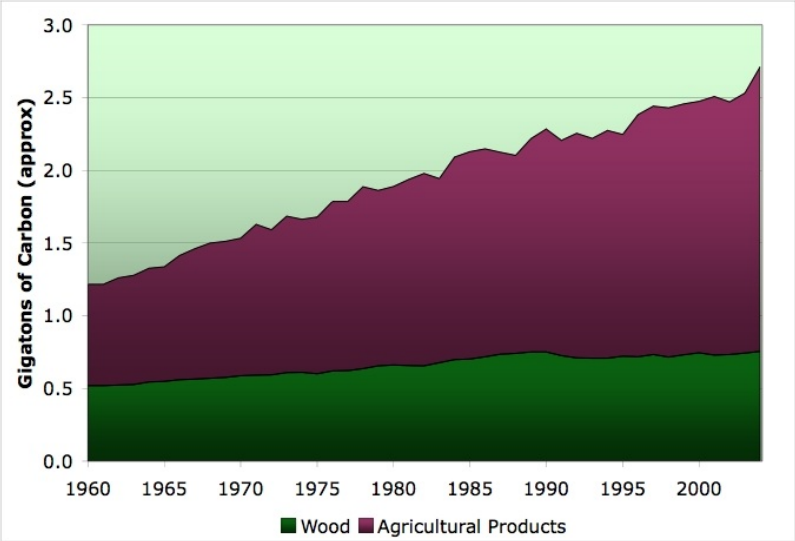
Will biofuels always be hopeless?

Posted by Stuart Staniford on May 26, 2006 - 12:04pm
Topic: Environment/Sustainability
Tags: biofuel, carbon cycle, climate change, global warming, hubbert peak, kyoto, oil prices, peak oil [list all tags]

I think most readers of TOD are persuaded that corn ethanol is a boondoggle right now. Robert Rapier made the case well again on Wednesday. Also, a little while back, Kyle argued pretty persuasively that cellulosic ethanol will not be much better in the near term.

Fair enough. I buy all that.

But, I think it's very important to ask: do biofuels suck for deep fundamental unchangeable reasons? Or for contingent reasons that might be amenable to change over time with technological innovation? And I'm starting to think the answer might not be so obvious.



Flows of carbon in biomass products entering the global economy. Source: FAO.

It seems an important point. Farmers, land grant universities, and agricultural suppliers have spent the last fifty years optimizing the efficiency of corporate agriculture on the assumption that fossil fuels are incredibly cheap. So no surprise that that produced a system with a very low EROEI. However, is there hope that given a different set of incentives and a few decades, they can optimize the system to create a different outcome? Brazilian ethanol has reportedly got an EROEI of around 10. So that suggests the situation might not be hopeless in principle.

To get a sense of the relative scales of things, let's remind ourselves again of the basics of the carbon cycle:

Earth's carbon cycle with stocks in Gt (Gigatonnes), and flows in Gigatonnes/year. Click to enlarge. Source: Wikipedia. Click to enlarge.

The Wikipedia's numbers are a little out of date. As I discussed some time back, by 2004, fossil fuel emissions were up to about 8Gt/year and climbing fast.

Still it's of considerable interest that the amount of carbon moving through the biosphere is an order of magnitude larger than the flux of fossil fuels. To repeat myself:

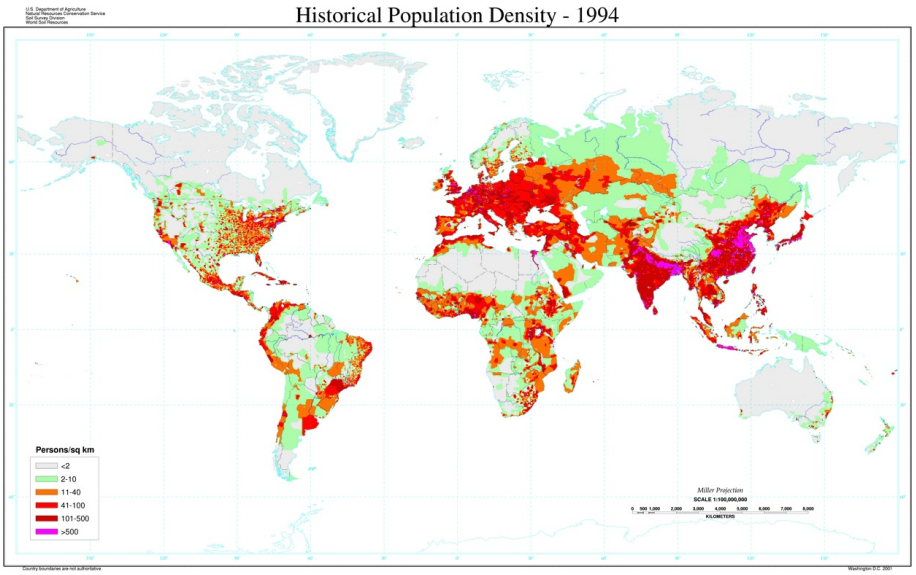
> Plants absorb about 120 Gt of carbon/year and turn it into sugars via photosynthesis (and then onto other materials). This is the *gross primary production* of photosynthesis in the biosphere. Of this, the plants themselves burn about 60 Gt of carbon (in the form of sugars) to power their own operations, so that is released out into the atmosphere again immediately. The remaining 60Gt or so is called the *net primary production*. Almost all of the net primary production ends up going into the soil (a small amount passing through some animal on the way), but humans use and burn some of it. The soil releases back pretty much all of the carbon influx through the action of decay organisms.

Obviously, the energy density of biomass is not as high as that of coal or oil, but still, the ratio of energy flows is not going to be completely different than the 60/8 ratio of net primary carbon fixation to fossil fuel carbon usage (especially if we grant solar drying of the biomass). It's not obvious to me that there's **no** combination of technology, policy, and economics that could divert a sizeable fraction of that 60Gt into biofuels. It's also not obvious that there isn't scope for innovations to increase that 120Gt top line over time (especially in a world with more CO_2 in the air to start with).

Here's a picture of the geographical distribution of primary producers:

Geographical distribution of plant density. Source: Wikipedia.

If we overlay that with human population density:



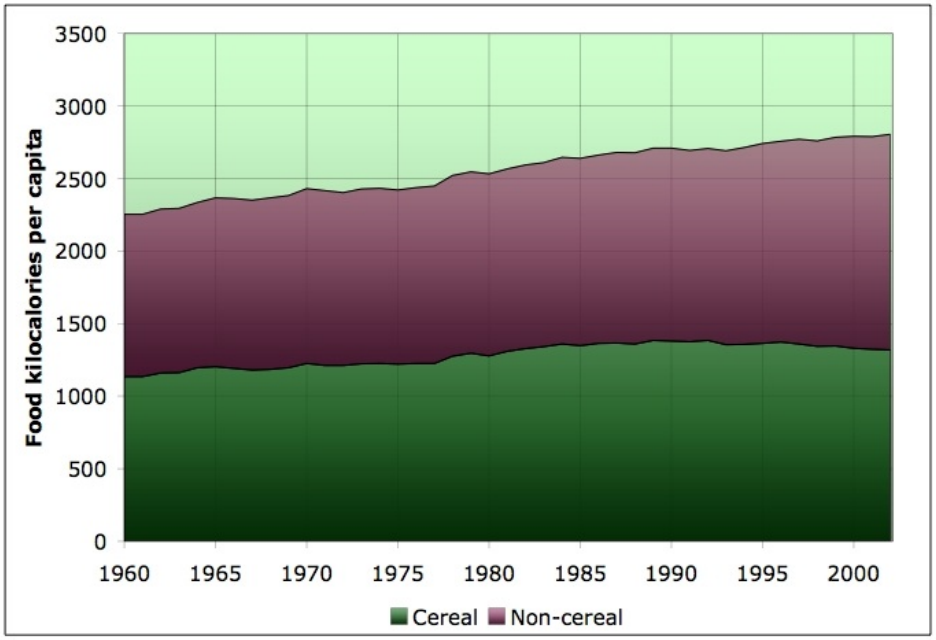
Estimated population density of the Earth in 1994. Source: NASA.

you can see why Brazil is the home of biofuel: the ratio of plants to people is probably as high there as anywhere. Thus the scope for using the plants to transport the people, as well as feed and clothe them, is exceptionally good.

But the US looks pretty good too. Europe, India, China, not so good.

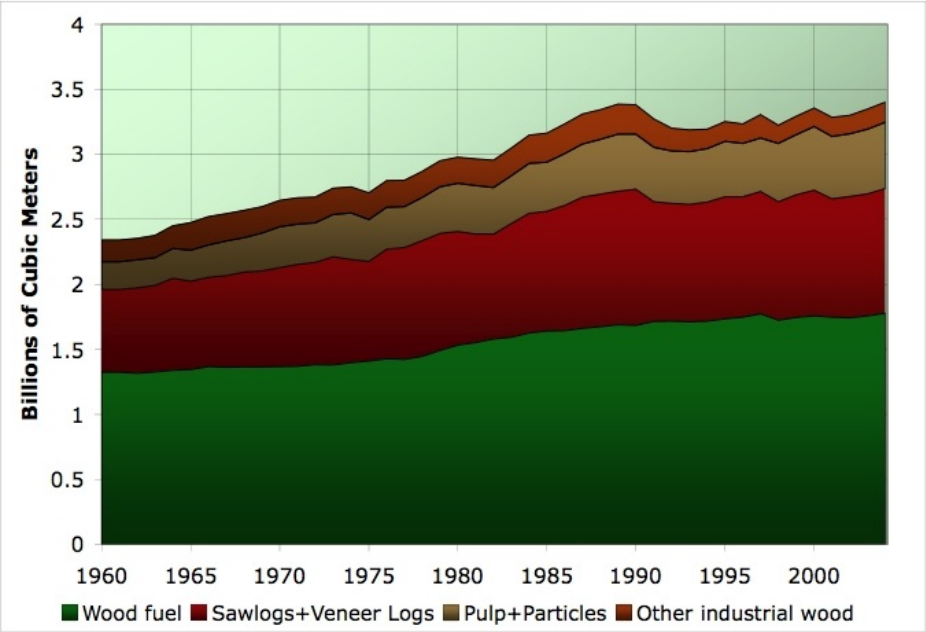
How much of that 60Gt of global net primary productivity makes it into the economy now? I did some digging around at the United Nations Food and Agriculture Organization. It turns out that the major flows are wood and food (textiles and liquid biofuels are fairly neglible by comparison at present).

Let's take food for a moment, and just reassure those of you worried about peak food; we don't seem to be there yet (at least as of 2002). Here's calories/capita. Although cereal calories per person have peaked, total calories per person have not.



Global calories/capita 1960-2002. Source: FAO.

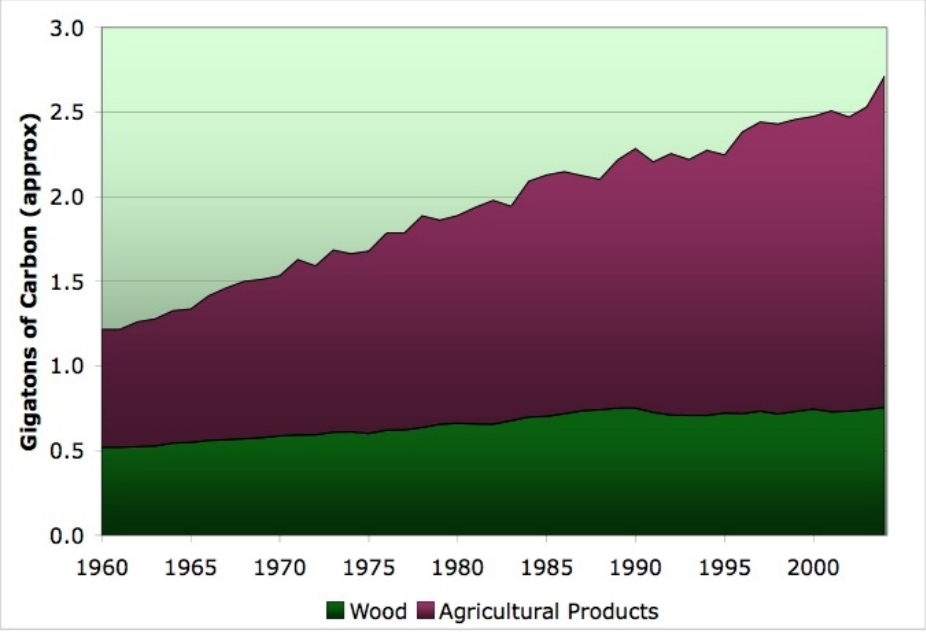
For a quick feel of what's involved in wood products, here are the major flows:



Global production of forestry products. Source: FAO.

Of course, these statistics should be taken as only rough indications. Adding up national statistics for wood production from a bunch of developing countries probably does not give a precision result.

Anyway, if we convert the FAO statistics into approximate carbon flows, we get:



Flows of carbon in biomass products entering the global economy. Source: FAO.

As you can see, only about 2.5Gt out of about 60Gt of net primary productivity makes it into the global economy.

Now I don't know enough to say how much that flow could be increased, nor how bad the resulting environmental impacts would be. But I think it's rather hard to make the case that

getting to the order of magnitude of 8 Gt/year is ***impossible in principle***.

But I do know that we've reached the point where defending our right to emit carbon on the scale we're doing it is several steps down the moral ladder from defending tobacco companies as innocent of causing cancer.

On the contrary, I believe we are ***committing evil*** in emitting so much carbon, and we need to change. We are heading for disaster after disaster.

And I think that's an important point when considering the subsidies for ethanol. Whenever the US, China, etc decide to leave the dark ages on these issues it's pretty obvious what needs to happen at an economic policy level. There needs to be big costs for anyone that emits carbon, and big payments to anyone who can prove they are sucking it out of the atmosphere and stashing it somewhere for a reasonable period of time. That would give everybody the right incentives and make possible business models for innovations that move us in the right direction.

Now, the ethanol subsidies are not what is needed. But they do at least have the right sign: they prefer biofuels to fossil fuels.

The closing price for carbon emissions today on the European exchange was €19.10/ton (about $24.40). Given about 2.4kg of carbon per US gallon of gas, that corresponds to about 6 cents/gallon. That's pathetic. In my opinion, it should be set on a ramp to go from the present value of nearly nothing to many dollars/gallon over the course of coming decades. And then the ethanol subsidies in 2006 might not look so big.