

## **The Biofuel Delusion - Synopsis of the Argument and Implications for ZeroCarbonBritain 2030's Land Use Proposals**

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With thanks to Mario Giampietro and Kozo Mayumi for kind permission to reproduce their graphics.

### Slide 2

The presentation runs through the basic argument of *The Biofuel Delusion*, by Giampietro and Mayumi (Earthscan, 2009), and draws implications for ZeroCarbonBritain 2030's proposals (CAT, 2010). The analysis makes use of trophic methods, introduced with the example of a mature forest ecosystem. The stocking density of each level in the feeding hierarchy is dependent on the density of life forms in the lower level, ultimately plants. The stocking rates are therefore constrained by relations of congruence between life forms, the pace of the solar flow and the efficiency with which plants convert it to biomass.

### Slide 3

In a zoo, food is imported from outside its territory. It's as if it were mining a large stock of meat. But if we imagine sourcing the food from a distant forest we can see that it would be dependent on a very large forest area, which can be calculated using these same relations of congruence. A similar thought experiment can be conducted if we imagine replacing fossil fuels supplies (mining a stock of energy resources) with liquid biofuels (harvesting a flow of solar energy and transforming it into liquid fuel). The authors present this thought experiment in both simplified form and with detailed workings.

### Slide 5

With oil, a small amount of the output of the energy sector has to be reinvested there to keep it going. In other words, the high output/input ratio implies that a large majority of the output is a net injection of energy to the other sectors of the economy (net-energy- approximates gross-energy-output). The figure shows per capita "total exosomatic throughput" (TET) for a highly developed economy such as the USA. This is broken down into energy delivered to final consumption (HH), building & manufacturing (BM), services and government (SG), and the energy sector. For such an economy, this throughput is achieved using only 10 hours per capita of labour input into the energy sector.

### Slide 6

In the thought experiment, we keep the delivery of net energy to HH, SG and BM the same as it was before and see what this implies for the energy sector - conducting the "heart transplant". Although output/input for biofuels is assumed to be 1.33/1, for every 1.33J of gross energy output, 1J needs to be reinvested to keep driving the energy sector. So a net supply of 1J implies 4J gross output and 3J internal consumption by the energy sector. More realistic values for output/input for corn-derived ethanol are 1.1/1, which implies a gross/net ratio of 11!

### Slide 7

Keeping the labour requirements of the energy sector constant, given the massive increase required in gross energy supply, means supplying much more energy per

hour of energy sector labour. But this is impossible - a process based on harvesting and transforming a solar flow of given density and pace will have a **lower** metabolism than one based on mining and transforming a pre-existing stock of energy carriers. It seems that large scale agro- biofuels would therefore imply **energy slavery** for much of the world's population - a very different kind of society to that being promised by the biofuel lobby.

#### Slide 8

What's going on here is that as the output/input ratio approaches 1, the ratio of gross to net energy approaches infinity. And this is before we account for the land use requirements...

#### Slide 9

Using biomass directly, for heating for example, implies a power density per square metre of around 0.5W - a maximum of 2W/msq. With bioethanol, one first ferments the corn then processes the ferment to extract the ethanol. So the spatial energy density is correspondingly lower, and lowered further by the spatial requirements of associated infrastructure.

#### Slide 10

This leads to the following estimates. I have done back of the envelope calculations for the biofuels component of ZCB 2030, which do not take into account spatial infrastructure requirements and use the top of the range figure for yields of biomass feedstock (switchgrass), and the figures quoted in ZCB for the energy content of 16t of switchgrass. Even with these maximally optimistic assumptions we end up with a spatial requirement of 70% of all UK land to be covered in switchgrass. So it's impossible even if we had the labour to supply this, and before we look at the land use requirements of the biomass and biogas streams on the following 'Sankey' diagram (slide 11).

#### Slide 12

To their credit, CAT have published an erratum online correcting the statement in ZCB that output/input ratios from second generation biofuels are higher than those from first generation biofuels such as corn-derived ethanol. But even if they *were* higher, if the ratio is anywhere below 5, G&M estimate that such processes are not viable replacements for fossil energy. G&M themselves do not really follow through in 'The Biofuel Delusion' on what kind of society they think is possible on the assumption that fossil fuels are not replaceable, but it seems to me that this question is what comes out of their analysis ... barring miracles.

#### Slide 13

In my opinion a key conclusion to draw is that one needs to abandon the ZCB 2030 commitment to keeping flying going. CAT have, understandably, two starting points: an 'aspirational lifestyle' and staying within ecosystem limits. Depending on one's conception of the former, there is no guarantee that they are compatible. Personally I would take the ecosystem boundaries as the foundation and then work towards an understanding of what material living standards and so on are possible. This may be a harder message to sell, but there is little point in selling a false message. This was also my impression regarding the recent 'Planet Under Pressure' conference in London, March 2012. The dead horse of "sustainable development" was still being flogged

hard, despite the evident fact that 30+ years of this compromised message have achieved almost nothing environmentally. The view there amongst the organisers seemed to be that if the message is radical policymakers will not listen. But that for me implies that they are not really listening in the first place.