Competition for Land, Fuel vs. Food

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SUMMARY

It is generally recongised that cereal prices and consequently the price of staple food products such as maize, corn, wheat and rice have increased significantly within the last two years as a result of competition for ground, between energy crops and food crops. A World Bank Policy Research Working Paper released in 2008 concluded that "…large increases in biofuel production in the United States and Europe are the main reason behind the steep rise in global food prices". Large areas of Brazil have also gone over to bioethanol production from sugar crops. If this model were to be repeated within Europe, it would have a further detrimental affect on food prices even though the areas under consideration are relatively small, compared to the resource in North and South America. However, in the interests of sustainability, it is important to ensure that additional energy crops can be established in such a way as to not conflict with food production.

In 2008, the UN Secretary General, Ban Ki-moon commented that several UN Agencies were conducting a comprehensive review of the policy on biofuels, as the World food crisis might trigger global instability. He said "we need to be concerned about the possibility of taking land or replacing arable land because of these biofuels". However, simply condemning the production of biofuels from land that could be used for food production, is not going to resolve the issue, we need to consider the alternatives and the environmental and human implications of using land for fuel production in lieu of food production.

This paper suggests how surveyors should be developing a response to "Social, Economic, Technological and Environmental change". The paper highlights the implications of switching from traditional food production to fuel production. It then addresses in terms of a needs analysis the factors that affect the decision including price, energy balance, resource allocation, need and sustainability. It is inevitable that the decisions will be made based on political and socio economic factors which are specific to each country.

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1. BACKGROUND

In December 2007, the United Nations Food and Agriculture Organisation (FAO) reported that World food prices had risen by approximately 40% in the previous 12 months. Those foods included basic feed stocks such as sugar cane, corn, rape seed oil, palm oil and soya beans. In July 2008 a World Bank Policy Research Working paper concluded that "… large increases in biofuels production in the United States in Europe are the main reason behind the steep rise in global food prices".

In 2006, 112 bioethanol plants in the USA consumed nearly 20% of the entire corn crop to produce 20 billion litres of ethanol. By 2007 that figure was up to 24 billion litres and though the figure for 2008 appears to be less, that is as a result of the global downturn and the fact that 20% of the plants have now closed. The competition for corn to either go into fuel production or food production is the best example of the competition for ground that is now so prevalent. The development of other crops such as rape seed oil requires a change in traditional agronomic practices. However simply diverting corn from the food chain into the energy industry is more straight forward, but problematic.

Significantly, it is not the efficiencies of the system which are switching corn from food into fuel production. It is as a result of a political imperative. In January 2008 President George W Bush called for 120 billion litres of renewable fuels to be produced within the United States, enough to replace 15% of all of the fuel consumed within American cars and trucks. Congress has further expanded this figure and is now looking at 250 billion litres by 2030. The drivers for this policy include the high price of oil (up to 2008) trying to ensure security of supply, especially the attempt to limit the green house gas emissions associated with fossil fuels which are contributing to global warming.

Using corn to produce bioethanol is probably the least energy efficient way to use the crop. Producing 10litres of bioethanol consumes the energy equivalent of approximately 7 litres of traditional gasoline and green house gas emission reductions are negligible.

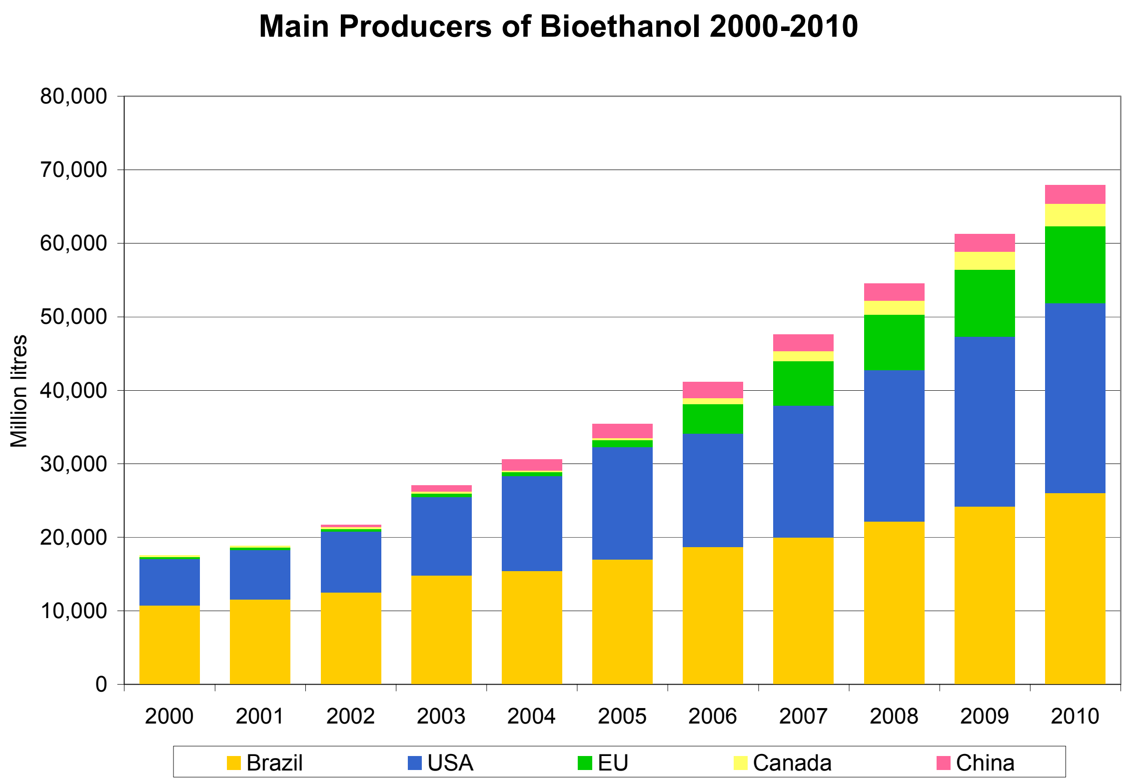
The rush to switch to "greener" liquid biofuels for transport isn't just a US phenomenon. The European Union has set a target of 5.75% of diesel fuel coming from bioenergy crops by 2010, though some of the European countries have already put those targets on hold until they identify how those targets might be achieved.

The demand for plant based liquid biofuels which has arisen as a result of policy development in the more affluent countries is having a negative impact on poorer countries who are struggling with increased food prices. For example in 2008:

- Egypt was forced to band rice exports to ensure that there was enough food to feed their own population

- China resorted to price fixing on grain, meat, milk and eggs to maintain stability in the market
- Pakistan was experiencing wheat shortages
- Indonesia was experiencing soya bean shortages
- Food riots erupted in Guinea, Mauritania, Mexico, Morocco, Senegal and Yemen
- Malaysia and Indonesia, which are large palm oil producers, were experiencing shortages of palm oil for cooking because prices had risen by up to 70%.

<u>Global growth of Non food crops bioethanol</u>



Ironically the high price for food, feeds back into the farmers who are producing it giving them better returns then previously experienced. This is particularly true in the US where corn reached a record high of over $6 per bushel in April 2007. Essentially it boils down to whether you are a producer or a consumer to determine whether you win or lose. If you are a net producer a rise in the food price is good for you: you make more money. If you are a net consumer a rise in the price of food is undoubtedly a disadvantage and it is this increase in price which affects the poor most severely.

2. THE PROBLEM

It is now generally accepted that producing ethanol from corn , using current technology, is not sustainable, is not economic as a liquid biofuel and that it also increases environmental degradation. Considering that one of the main drivers within the US for the production of bioethaonol was to provide energy security, it is dubious about whether this is attainable considering the relativity high amount of fossil fuel that is required to produce the ethanol. In addition, the diversion of corn from the food chain into the energy channel has proven to be a major contributing factor towards the increase in the cost of basic food stocks. It is interesting that this drive for bioethanol in the US was driven by policy and not by market factors at the time of its development.

Many would argue that sugar from cellulosic biomass is the answer. All biomass, including plants and trees is a source of sugar and of energy. It is now possible to break down the long molecular chains that form the complex carbohydrates within the plants and free the sugar for conversion to usable forms of energy. Therefore ethanol made from cellulosic materials, rather than corn, appears to be a better bet.

This is exactly what Brazil has been doing since the mid 1970's. Sugar cane ethanol production now provides a significant amount of Brazil's energy requirement and also supplies 30% of the world's total supply of biofuel. However this has had a significant environmental impact within Brazil, particularly within the Amazon and has also had widely publicised social effects on the indigenous peoples. Some commentators have argued that sugar cane production has not put a significant pressure on land use in the Amazon and that other crops such as soya are in fact the culprit and that the debate continues.

Certainly Brazil has been successful in producing low cost biofuels for the home market. As production has increased over the last 30 years, as a result of the Brazilian energy initiative, the amount of ethanol produced has gone up from 0.6 million cubic metres in 1975 to 15 million cubic metres in 2006. Costs have fallen as production has increased. One of the contributory factors in the development of the industry is the fact that Bagasse, which is a bio product of sugar cane crushing, is used in the ethanol plant, where it is burnt in boilers to provide heat for the process. The energy balance for ethanol produced from sugar cane is highly positive typically of the order of 8:1 to 10:1. However over the last 18 months there is evidence of production falling as a result of the withdrawal of financial incentives for the production of ethanol.

While Brazil is manor producer of liquid biofuels, the continent of Africa produces very little, outside of South Africa. The debate is now starting and the "for and against" arguments have already begun. With many of the Worlds poorest national populations being in Sub-Saharan Africa, it is important develop a strategy that both protects them and maximizes the opportunity to produce both bioethanol from starch and sugar, and biodiesel from vegetable oil.

The first difficulty in Africa is that traditional farming is made up of many decentralized small scale farmers, with low output, labour intensive farming practices. This conflicts with the tendency for the biofuel industry to gravitate towards large scale capitalised biofuel production, with global value chains and massive economies of scale. The second issue in Africa revolves around the dangers to the climate by introducing further large tracks of mono culture. Intensive biocroping tends to adversely affect soil fertility and at present it is uncertain what the extent of the damage could be to the African soils.

3. THE SOLUTION

This paper does not attempt to specify which crops should be grown on which land using a particular technology resulting in a preferred biofuel. What the paper does begin to address is the identification of the factors which influence the decision about the use of land to produce either food or fuel. It is up to each farmer, producer group, geographical area, or country to decide on the factors which are relevant to them. What this paper is attempting to do is to provide a decision making tool kit that will identify the advantages and disadvantages associated with a particular root and eventually quantify the implications.

The competing factors have been considered under six headings. They are:

1. Energy balance
2. Technology
3. Cost effectiveness
4. Policy
5. Need
6. Sustainability

The last one, Sustainability, is over arching and it could be possible to consider all of the factors simply as sub divisions of sustainability. However in the interim, it has been included as a stand alone factor.

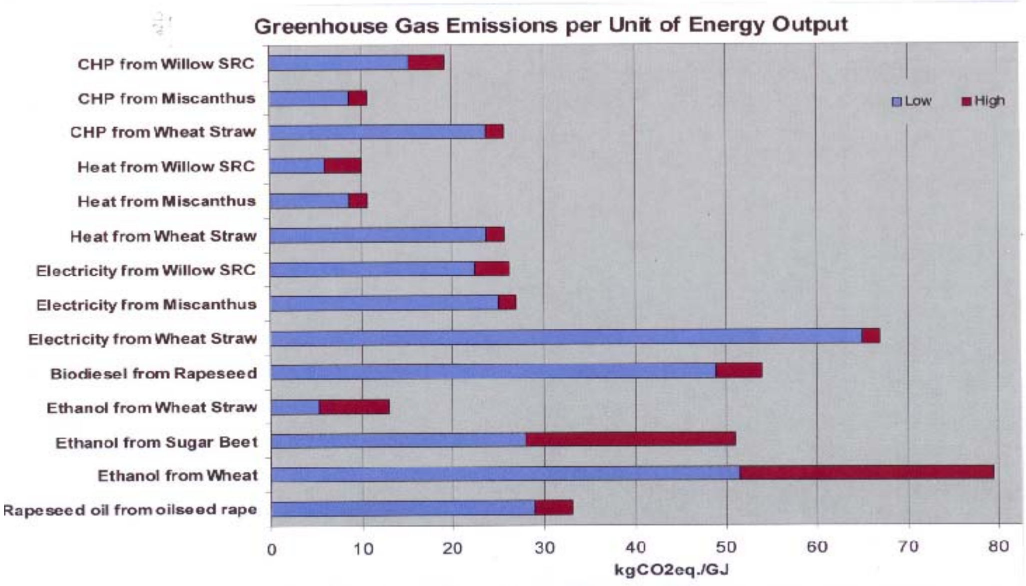
3.1 Energy Balance

There are three factors to consider within Energy Balance, they are:

- Green house gas emissions per unit of energy output
- Fossil fuel energy requirement per unit of energy output
- Energy out put per hectare of land

Attached below is a table showing green house gas emissions per unit of energy output for several crops using several technologies. It is immediately obvious that there is a very significant variation in the green house gas emissions depending on the crop type and the technology.

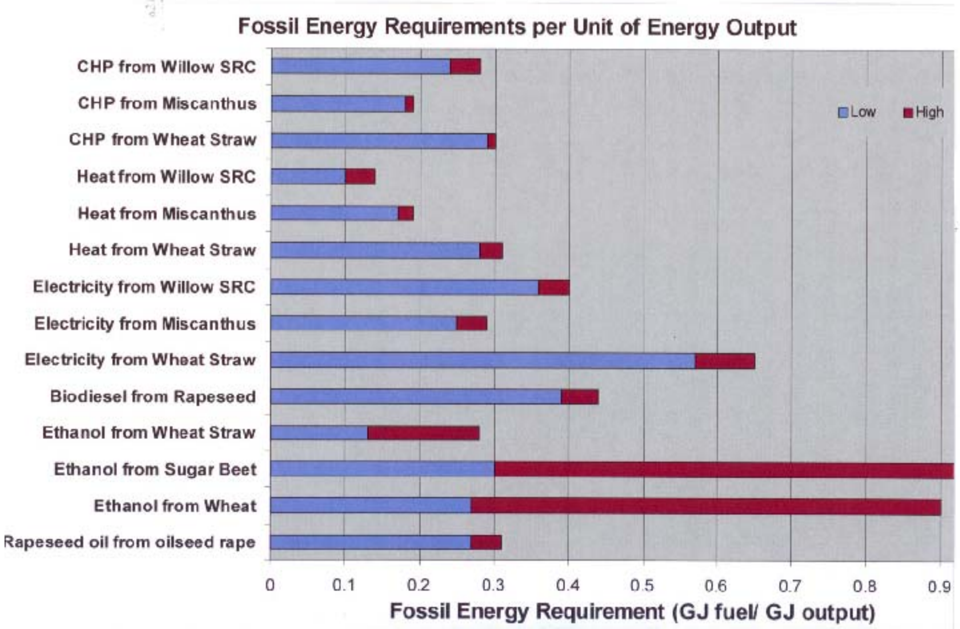
Differences in Bioenergy Sources



The table shown above relates specifically to emissions of carbon dioxide. There are also significant other greenhouse gases, particularly methane and nitrous oxide. While the volumes of methane and nitrous oxide associated with crop production are less than those for carbon dioxide they are considerably more potent i.e. methane is twenty times more potent than carbon dioxide and nitrous oxide is three hundred and ten times more potent. The intension is to identify and quantify the green house gas emissions for all of the crops which are likely to be grown in significant areas under consideration.

The table below shows the fossil energy requirement in terms of fuel input versus fuel output.

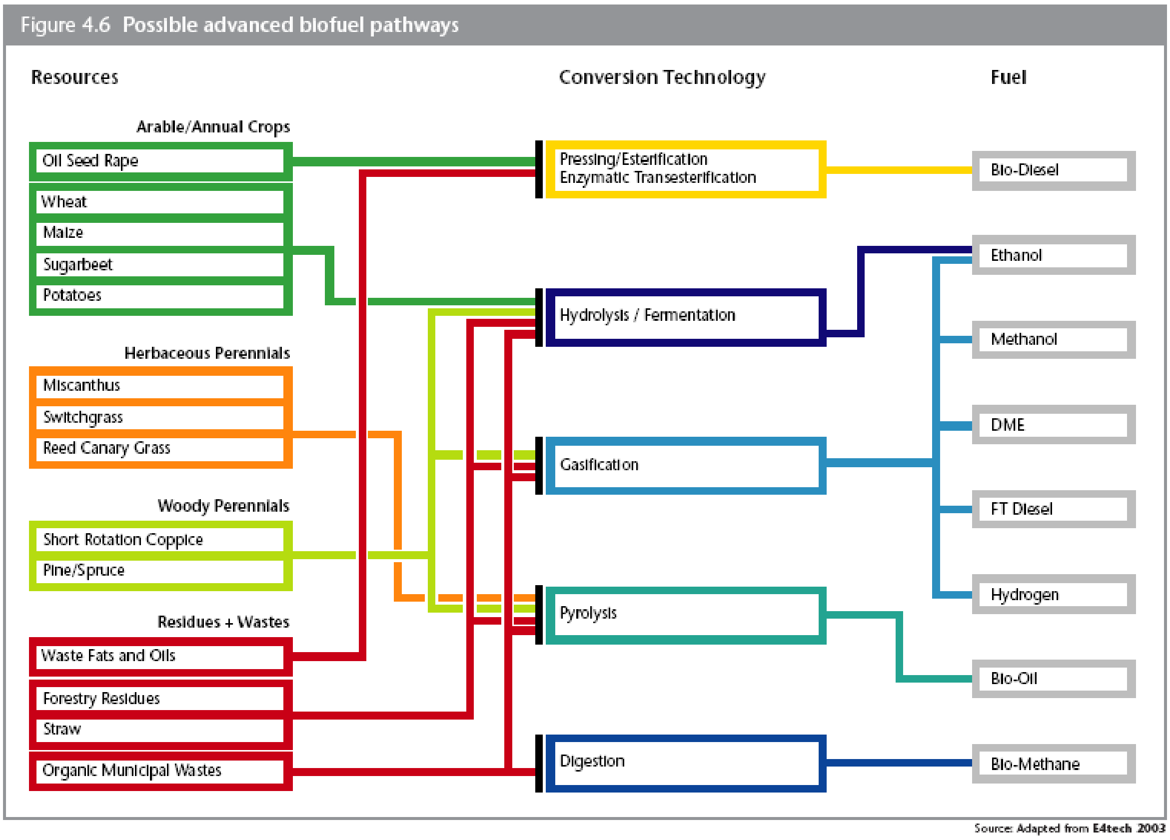
Differences in Bioenergy Sources



The crops and technologies shown above are similar to those considered in the previous table. There is even greater variation in the range of figures and it is interesting to note that ethanol from corn is not even on these tables. If it were to be included it would have a range from 0.8 up to 1.4, indicating that under certain circumstances it takes more energy to produce a litre of biofuel than can be subsequently be derived from it when it is used. There is another aspect to this which should be considered and that is the value of the energy itself. It is common for the value of electricity to be greater per kilowatt hour than for heat per kilowatt hour. This has been considered later under the section cost effectiveness.

The third aspect to be considered within energy balance is the energy that can be delivered from the crop in terms of its yield per hectare. This is not the same as the yield of the biomass crop itself, as the figure can be dependant upon the moisture content (which effects the calorific value) and the way in which energy is delivered from the crop. This will result in a table showing typical crops with their potential minimum and maximum energy yields related to their end use i.e. heat, electricity, or transport biofuel.

3.2 Technology



For the sake of clarity were considering the various path ways that are available for liquid biofuel production. This includes four categories of biomass resource being, arable/annual crops, herbaceous perennials, woody perennials and residues and wastes. We then have considered the various conversion technologies including esterification, hydrolysis/ fermentation, gasification, pyrolysis and digestion. There are also various sub divisions within these technologies such as single stage gasification, down draft gasification, fluidized bed gasification,etc, but the complexities of the various technologies are beyond the scope of this paper. We are then considering the various liquid biofuels that can be derived including, biodiesel, ethanol, methanol, DME, FT diesel, hydrogen, bio-oil and biomethane.

Not all of the conversion technologies are at the same stage of development. It is therefore likely that over the next few years the emphasis and the efficiencies of those technologies will change e.g. large scale pyrolysis may become more reliable and wide spread.

3.3 Cost Effectiveness

There are several factors affecting the cost effectiveness of biofuels these include the cost of making the fuel, the cost at which the fuel can sell and the carbon saving associated with the use of that biofuel in place of traditional fossil fuels. Below is a table presenting a range of figures indicating the cost effectiveness of certain fuels in terms of carbon saving mitigation.

Outputs of biofuel reports from the literature review

Study	GHG savings (%)	Cost per litre (ppl)	Cost-effectiveness (£/tCO2e)
World Bank (2007)			
Biodiesel	47-75%	33	33*
Bioethanol (maize)	10-20%	33	377*
Bioethanol (sugarcane)	60-90%	16	-35*
Greenergy (2007)			
Bioethanol (sugarcane)	77%	11	-95*
Concawe (2006)			
Biodiesel	40-70%	n/a	161
Bioethanol (sugar beet)	32-65%	n/a	185
Bioethanol (wheat)	30-70%	n/a	186
MEACAP (2006)			
Biodiesel (sunflower oil)	n/a	n/a	121
Biodiesel (OSR)	n/a	n/a	114
Bioethanol (sugar beet)	n/a	n/a	347
Bioethanol (wheat)	n/a	n/a	692
Bioethanol (maize)	n/a	n/a	289
CE (2006)			
Biodiesel (OSR)	40%	n/a	207
Bioethanol (wheat)	30%	n/a	448
Bioethanol (sugar beet)	30%	n/a	379
Bioethanol (sugarcane)	80%	n/a	n/a
UNSW (2006)			
Bioethanol (sugarcane)	90%	10	-113*
Imperial College (E4tech) (2005)			

Biodiesel	40-60%	n/a	n/a
Bioethanol	7-70%	n/a	n/a
Bioethanol (sugarcane)	70%	n/a	23
Sheffield Hallam (2003)			
Biodiesel (OSR)	57-80%	n/a	n/a
DfT (2002)			
Bioethanol (oil seeds)	54%	41.2	151*
Bioethanol (wheat)	54%	30	175*
Bioethanol (sugar beet)	54%	34	219*
Bioethanol (sugarcane)	70%	12.6	-9*
ABARE (2001)			
Bioethanol (sugarcane)	70%	n/a	51

These are calculated values based on outputs from the studies as no cost-effectiveness figures were given.

Obviously there is a range of figures. This has occurred because of the method of production, the maturity of the technology at the time that the figures were prepared and the consideration of the life cycle costing, which is not consistent across the figures. It is therefore important to agree on the range of figures that would be appropriate in a particular situation rather than insist on using a specific figure for all applications. This element of the statistical determination of what's happening is necessarily a bit vague at this stage, as it is again not within the remit of this paper to produce research that can accurately identify the mitigation costs for all fuels for all scenarios, using a consistent life cycle analysis bases. It is therefore important to follow trends and indications rather than specific figures.

3.4 Policy

The Policy aspects consider both tangible and intangible items. The tangibles include policies associated with climate change mitigation, increased energy security and research and development options. The intangibles, which are usually harder to quantify are associated with issues such as public perception and ethics.

The issue of energy security is very much associated with natural resource potential. Countries which already have large reserves of wood or the capacity to produce large quantities of liquid biofuels from a traditional agricultural crops that have in then past, gone into the food chain have short decision chains to address, there only difficulty is in determining what proportion of the food crop can be diverted to energy production without prejudicing the food supply for their people. I would hope that there is not an issue associated with the export of liquid biofuels out of a region or a country for financial gain which has diverted natural resources from the food chain within the country. However this has already happened in several countries.

While green house gas emissions per hectare of land associated with biofuels has already been mentioned in the energy balanced section, this issue is also relevant within policy. It is generally recongised that using wood for electricity generation offers carbon dioxide savings per hectare in the region of three to five times greater than for biofuels diverted from food crops and about twice that of biofuels from lignocellulose.

Within most countries, electricity generation is a regulated industry. In the past this has lead to a more immediate impact on renewable energy production being achievable within the electricity market both for reasons of technology and for reasons of policy fit i.e. Governments have greater control over the electricity market and can achieve short term results when considering renewable energy targets faster in the electricity route. This may well be a policy decision rather than a simple decision based on cost effectiveness. Within the UK this is evident, as the amount of electricity produced from biomass in 2008 was greater than the amount of heat produced from biomass simply because of the co-firing policy requiring higher levels of biomass feed stock within the electricity generating stations. However the efficiencies of conversion are typically of the order of 25-30% within electricity generating stations whereas efficiencies of 90% could have be achieved had the biomass gone directly to heat. This occurred as a result of policy drivers.

Environmental factors including, biodiversity, water retention and climate change mitigation itself are policy driven. The picture is further complicated by the fact that it is possible within the developed world to have policy initiatives which are counter-productive. The commitment of the European Union to increase the amount of road transport fuel from biosources creates the possibility to export the environmental problem to developing countries. In effect the poorer countries will be supplying the fuels from regions with environmentally unsustainable cropping and forestry practices to feed the green issue driven policy of the developed world. It is therefore important that the overarching issue of sustainability is a corner stone of any policy initiative.

3.5 Need

While all nations and their farmers can profit from the production of biofuels, poor countries have the potential to derive most benefit, because they suffer disproportionately when the price of oil goes up. This was evident in 2007 and in early 2008 when oil and food prices rose significantly. By investing in biofuels, developing nations can produce their own domestic transportation fuels, cut their energy costs and create new jobs in their local economies. It is possible for developing nations to convert part of their agricultural output to fuel, thereby entering a higher value market with good demand. This is essentially fulfilling a need to move up the value chain.

It is interesting that globally agriculture is now entering a phase where there is unlimited demand for its produce. Subsidies are usually a response to lower prices and inadequate market conditions and therefore with increased demand subsidies could be become unnecessary. Developing countries could therefore reduce or phase out tariffs and reduce subsidies for food and fibre crops and divert their energies into the production of liquid biofuels. This has the inherrent risk of diverting food crops to the energy chain but it does fulfill a need to provide increased income. As mentioned previously sustainability has an over arching effect on this debate. The way in which the fuel versus food debate pans out will be largely as a result of the amount of attention that's paid to sustainability. In my opinion any decision which does not seriously consider the impact on sustainability is likely to be a short term, quick fix solution with a long term devalued outcome. At the moment the pressure to develop biofuels is largely as a result of our need to address sustainable transport issues. If however we simply address the fuel issue, we will just create further problems back up the value chain with unsustainable methods of agriculture. We have to recongise that biofuels alone cannot delivery a sustainable transport system. They should be part of an intergraded package of measures and this is likely to take some of the pressure off the "dash for liquid biofuels" that we seem to be experiencing at the moment.

The factors affecting sustainability include:

- Feedstock production
- Land use and land diversification
- Biodiversity
- Maintaining balanced eco systems
- Whole life costing of the system, not just the fuel
- Environmental pollution
- Social aspects
- Economic aspects

It is generally accepted that the World Trade Organisation rules apply to energy products, including renewable energy. While the WTO has its critics it is nevertheless likely to be an important factor in developing sustainable biofuels. The way in which the rules have been applied to date means that they generally address import barriers more than export barriers. As issues associated with security of supply encourage low import duties, many see this as an opportunity. It is possible that some of the poorer countries have the potential to be significant producers of biofuel, providing them with an important source of revenue. Therefore if those discussions continue, based on sound principles of sustainability the outcome is likely to be more beneficial for everyone.

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BIOGRAPHICAL NOTES

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Michael is the Business Development Director with Rural Generation, a biomass company based in Northern Ireland. He graduated from the University of Salford in 1978 and began working life as a Quantity Surveyor. In 1982 he was a founding partner in Holmes and Doran, a multi-disciplinary practice, of Quantity Surveyors, Building Surveyors and Project Managers. Originally based in Northern Ireland, the practice expanded in 1995, to include an office in the Republic of Ireland.

Michael has been involved in the RICS since 1992. He was an assessor for the APC in the Construction route, until 2002, and has been on the N.I Council of the RICS in several capacities. He is the current Chairman of the Northern Ireland Environment Faculty, and is the Past Chairman of the International Environment Faculty of the RICS. He has been involved with FIG since 2004 and has presented papers at conferences in Munich and Stockholm on energy crops and the potential for the EU to produce bioenergy.

He is also a Chartered Environmentalist, and a Member of the Institute of Directors. He was a founder member of the Irish Bioenergy Association, in 2000, and was their P.R. Officer until 2005. He was the Irish representative on AEBIOM, the European Biomass Association from 2002 to 2006 and sat on the Energy Crops Committee of DG Agriculture until 2005.

Married with 4 children, Michael's interests include horse riding and boating. He is also a qualified basketball and swimming coach and has played basketball to international level.

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