Bio-energy – opportunities for agriculture, industry, and waste management

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Discussion Paper

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Bio-energy, which is energy generated from renewable biomass, covers a wide range of materials and processes. Potential bio-energy sources include conventional agricultural crops such as beet and oil seed rape; crops such as coppice willow and miscanthus (elephant grass); and a range of other biodegradable waste materials such as timber by-products or used cooking oils. These energy sources are alternatives to fossil fuels but to-date market conditions have not favoured the widespread development of bio-energy fuels. Increasingly policy makers and consumers are focusing attention on further developing renewable energy, driven by issues such as rising fossil fuel prices, EU energy targets, Kyoto protocol and national climate change targets. There is also an increasing focus on developing bio-energy diversification opportunities for the farming sector due to reforms in the common agricultural policy. Greatest development focus has been on wind energy but other renewable energies also have significant potential plus offer environmental benefits. The purpose of this paper is to draw attention to the subject of bio-energy within the wider public discussion on renewable energy and in particular highlight the scope, opportunities for the development of bio-energy in Ireland.[1]

Current Status of Bio-energy[2]

Energy supplied into the Irish market is dominated by non-renewable fossil fuels. In 2004 almost 97% of the national primary energy requirement was supplied by the combustion of fossil fuels (see figure 1). Within electricity generation 5.2% of electricity output was derived from renewable energy sources in 2004. Specifically within renewable electricity, just 6% of electricity generated derives from biomass. At present therefore bio-energy comprises only a tiny share of total energy consumption.

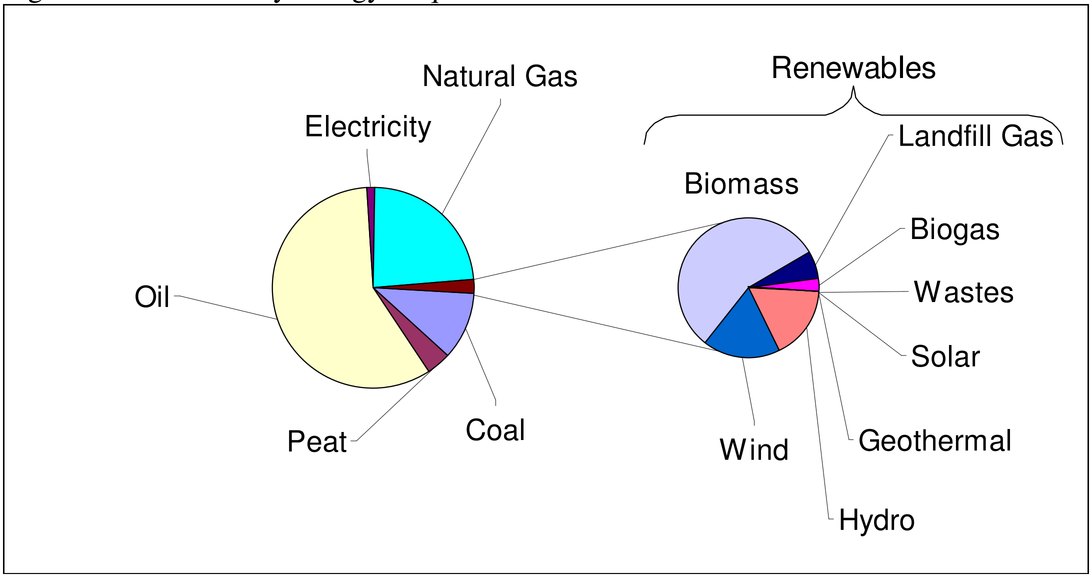
In a few specific sectors biomass energy consumption does account for a significant proportion of total energy consumption. Approximately 80% of the wood products sector's final energy consumption in 2004 was sourced from biomass (e.g. waste wood) amounting to 141ktoe,[3] whereas the food and beverage sector utilised some 5ktoe of biogas in 2004 representing a 1% share. The residential sector also consumes a large volume of biomass energy (e.g. firewood) amounting to some 43ktoe in 2004, though this accounted for just 2% of its total final energy consumption.

[1] It is expected that a Green Paper on energy policy will be published by the Department of Communications, Marine and Natural Resources in summer 2006.

[2] The statistics in this section are sourced from Howley, Martin, Fergal O'Leary, and Brian Ó Gallachóir. 2006b. "Renewable Energy in Ireland 2005 Update." Sustainable Energy Ireland.

[3] ktoe = Thousand tonnes of oil equivalent

Figure 1: Total Primary Energy Requirement 2004*



* Total primary energy requirement includes energy production, net imports (incl. electricity imports), marine fuel bunkers and energy stock changes.

Table 1: National Energy Balances 2004

Units – ktoe[1]	Fossil Fuels	Biomass	Biogas	Electricity	All fuels[2]
Total Final Energy Consumption	9,613	184	7	1,983	11,788
▪ Industry	1,443	141	5	592	2,181
▪ Transport	4,685	0	0	13	4,698
▪ Residential	2,207	43	0	632	2,882
▪ Commercial/Public Services	1,016	0	2	694	1,712
▪ Agricultural	262	0	0	52	314

Source: SEI
1. Thousand tonnes of oil equivalent.
2. Includes small amounts of solar and geo-thermal energy.

Policy Drivers

Current developments in world fossil fuel markets are driving significant change in the renewable energy sector. Fossil fuel prices have fluctuated widely over the past few years creating considerable uncertainty for trade and investment, which has prompted companies and governments to develop renewable energy resources with the objective of dampening the worst consequences of price uncertainty. On top of short-term price fluctuations, energy prices have been trending steadily upward and as a consequence improving renewable energy profitability. For example, crude oil prices in 2005 were roughly 40% higher than 2004 prices and 75% higher than 2003 prices.

The continual depletion of the finite resource of fossil fuels is also driving policy to develop alternative fuel sources. Global peak oil production is anticipated within the current decade, after which oil extraction will decline. In the case of coal many of the most accessible coal seams have already been extracted. The implication is that renewable energy alternatives, including biomass, are increasingly becoming both a necessity and a cost competitive alternative.

European energy policy is also a major driver of change in the bio-energy sector. The European Commission recently adopted a detailed action plan to increase the use of energy derived from biomass.[4] The plan announced over 20 specific measures that the Commission anticipates will more than double the use of biomass energy by 2010. In March 2006 the Commission published a Green Paper on energy policy, which will further strengthen and support renewable energy development.[5]

A number of existing EU directives are already driving efforts to increase the use of bio-energy in Europe. Under EU Directive 2001/77/EC Ireland has a target to increase electricity produced from renewable energy sources to greater than 13.2% by 2010. At present approximately 6-7% of electricity is from renewable sources. The EU Biofuels Directive[6] sets an indicative target of a 5.75% share of the transport fuel market for renewable and bio- fuels by 2010. Biofuels currently have a negligible market share in Ireland.

EU agricultural policy reform is also driving change in the bio-energy sphere. With most agricultural subsidies no longer linked to production, farmers are looking for opportunities in non-traditional enterprises. Production of energy crops is one enterprise is likely to expand as markets develop.

The Irish government has introduced a number of schemes to promote renewable energy and transport bio-fuels. The Department of Communications, Marine and Natural Resources (DCMNR) introduced a Renewable Energy Feed In Tarriff (ReFIT) in 2005, which provides a top-up subsidy to renewable electricity producers. Previously the DCMNR supported renewable energy projects by way of competitive tendering under the Alternative Energy Requirement (AER) programme. The DCMNR also introduced in 2005 a pilot programme for Mineral Oil Tax (MOT) relief on 16 million litres of biofuels. In December 2005 the DCMNR also announced that further schemes would be launched during 2006 costing €200 million over 5 years.

Bioenergy potential

The EU has a series of renewable energy targets to be achieved by 2010. These targets are a 12% overall share for renewable energy, a 21% share in the electricity sector and a 5.75% share for biofuels.[7] European Environment Agency research suggests that the EU could double its use of biomass for energy use by 2010 while complying with good agricultural practice, safeguarding sustainable production of

[4] Commission of the European Communities. 2005. "Biomass Action Plan." COM(2005) 628
[5] Commission of the European Communities. 2006. "Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy." COM(2006) 105
[6] Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport.
[7] Commission of the European Communities. "Biomass Action Plan."

biomass and without significantly affecting domestic food production.[8] The ability of individual member countries to increase their domestic bio-energy supply will vary considerably and it is therefore instructive to examine in further detail the opportunities, constraints and geographical distribution of potential bio-energy supplies within Ireland.

The main bio-energy resources currently exploited in Ireland are landfill gas, waste biomass, and energy crops. Further potential is feasible in each of these areas but all are subject to constraint.

- **Landfill Gas**

  Bacteria cause the organic fraction of landfill deposited waste to decompose and produce a biogas. Using a well-established technology this biogas can be recovered and used to generate heat and electricity. Over 21 MWe[9] of capacity is currently installed and exploits a small fraction of this resource, which is forecast to total 304 MWe feasible capacity by 2020.[10]

  Though substantial growth in landfill gas recovery is anticipated its longer term potential is limited. The number of landfills available is finite and their capacity to produce gas will eventually be constrained by the aims of the EU Landfill Directive,[11] which seeks to dramatically reduce the amount of biodegradable municipal waste consigned to landfill.[12] However, given the current high volumes of biodegradable municipal waste being disposed in landfill and the lag period between waste disposal and decline in gas production, it is likely that the potential landfill gas resource available for recovery will not decline to any extent before 2020.[13]

- **Waste Biomass**

  While compliance with the EU Landfill Directive will eventually reduce the landfill gas resource, a corollary is that there will be an increase in the volume of waste resource directly available for energy recovery. Several options are available to recover bio-energy from waste: individual waste streams can be processed and refined into a marketable fuel (e.g. recovered catering oils processed into transport fuel); incineration with energy recovery of individual waste streams, (e.g. waste wood products); while organic wastes can be processed by anaerobic digestion to release biogas for use in electricity generation or as a transport fuel.

  At present approximately 7,000 tonnes/year of recovered vegetable oil (RVO)

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[8] European Environment Agency. 2006. "How much bioenergy can Europe produce without harming the environment?" EEA Report No 7/2006; European Environment Agency. 2005. "How much biomass can Europe use without harming the environment?" EEA Briefing 2005-02

[9] MWe = megawatts of electricity

[10] Renewable Energy Information Office. 2001. "Landfill Gas in Ireland - The Facts." Irish Energy Centre. 21 MWe – 304 MWe is roughly equivalent to 0.4 –5.8 million gigajoules of energy.

[11] Council Directive 1999/31/EC on the landfill of waste.

[12] The target for 2016 is that 35% or less of the 1995 baseline volume biodegradable municipal waste is deposited in landfill. In 2004 101% of the baseline was confined to landfill.

[13] Sustainable Energy Ireland. 2004. "Updating the Renewable Energy Resource In Ireland (2004)."Report No. 4P305A-R5

is being collected with potential for a further 3,000 tonnes/year with improved collection systems.[14] A further 50-60,000 tonnes of beef tallow is produced annually by the rendering industry. Historically both RVO and tallow were used in animal feeds but this is no longer permitted for animal disease control reasons, while tallow is used to fuel boilers in rendering plants.[15] An alternative viable outlet for both RVO and tallow is to process it into a transport fuel – biodiesel.[16] The potential energy output from RVO and tallow is dependent on the quality and type of inputs into the refining process, however, as an indicator of its potential energy resource some 55,000 tonnes of RVO/tallow has an estimated energy potential of approximately 45.9ktoe, which has an energy value equivalent to 51 million litres of diesel.[17]

Forestry operations residues, mostly branches and treetops, are a potential renewable energy feedstock. With a national forest area approaching 700,000 hectares and an annual production of some 3 million m^3 of timber, total forest residues are estimated at 300,000 tonnes of which some 200,000 tonnes is potentially accessible and available for collection for energy recovery purposes.[18] A further 300,000 tonnes of wood residues are potentially available as an energy feedstock from the wood processing industry, which is additional to the energy recovery currently undertaken within the wood processing sector.[19] In total there are some 0.5 million tonnes of wood residues potentially available for energy recovery, which have an equivalent energy value of approximately 256 million litres of kerosene or one-quarter of total kerosene consumption in Ireland in 2004.[20]

Whether for wood biomass or RVO the existence of a large potential energy resource does not guarantee that its recovery is either economically viable or environmentally sustainable. Energy recovery from wood biomass residues is a case in point. Transportation of wood biomass residues, which are widely dispersed geographically, to a centralised processing centre and the distribution of the fuel product (e.g. wood pellets) back to a widely dispersed market would entail both significant economic costs and also energy consumption. In the case of wood biomass the net energy balance after collection, processing and distribution would be substantially lower. Even so there are several additional benefits of energy recovery from waste biomass including less waste being disposed in landfills, improved performance on Kyoto targets, and an improved indigenous energy supply.

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[14] Rice, B.G. and A. Fröhlich. 2005. *The Potential of Recovered Vegetable Oil and Tallow as Vehicle Fuels*: Teagasc.
[15] Commission Regulation (EC) No 2067/2005 of 16 December 2005 amending Regulation (EC) No 92/2005 as regards alternative means of disposal and use of animal by-products.
[16] RVO can be used as a fuel in modified diesel engines or further processed into biodiesel. Tallow is not suitable for use in modified diesel engines.
[17] Assuming calorific value of 35 MJ/kg from oils and fats.
[18] Rice, B. 2003. "Energy Crops - Have They a Future." *National Tillage Conference 2003*. Teagasc.
[19] Rice. "Energy Crops - Have They a Future."
[20] Assuming an energy content of 15 GJ/t for forestry residues and 22 GJ/t for woody biomass from the wood processing sector (Jensen, Peder. 2003. "Scenario Analysis of Consequence of Renewable Energy Policies for Land Area Requirements for Biomass Production." European Commission - DG JRC/IPTS). GJ = gigajoule and 1GJ = 0.02388 tonnes of oil equivalent.

- **Energy Crops**
  A range of crops may be grown for energy production in Ireland including oil seed rape, sugar beet, potatoes, wheat, short rotation coppice willow and miscanthus. Increased production of such crops is widely advocated as a panacea for our renewable energy deficits but its potential as an energy source is not boundless. A primary limiting factor is the availability of land for crop production. While all agricultural land is potentially available for production, energy crops will only be grown on lands where it is profitable to do so and this will primarily be on arable land, which is shown in Figure 2 below.

  Some 325,700 hectares of tillage crops were sown in 2005, which is an 8% decline on 2004.[21] In total there are over 400,000 hectares of prime tillage land but only a fraction of this would be available on an annual basis for energy crops. Based on a 4-5 year rotation cycle the maximum area available to a single energy crop is roughly 80-100,000 hectares. The energy potential of 80,000 hectares depends on crop choice and yield; oilseed rape for example, would yield in excess of 100 million litres of transport fuel in the form of pure plant oil (PPO).[22] One hundred million litres is equivalent to 4% of auto diesel consumed in 2004.[23] If several energy crops are sown in rotation (e.g. oil seed rape, sugar beet, wheat, barley) the total energy potential could be much higher.

  The opportunities to grow woody biomass energy crops, such as short rotation coppice and miscanthus, extend beyond traditional tillage areas. While Teagasc research suggests that the most suitable areas for growing short-rotation forestry are in the tillage intensive areas, there are suitable sites in all parts of the country.[24] There is also potential that common alder (*Alnus glutinosa*) could be grown as a biomass crop on cutaway peatlands.[25] At present there is an estimated 200 hectares of willow plantation in the Republic of Ireland and COFORD estimate that there is a potential for 10,000 hectares of short rotation coppice (SRC) willow by 2010 subject to market development and policy support.[26] That level of plantation would give an annual harvest equivalent to 48 million litres of kerosene.[27]

- **Grass as an Energy Crop**
  Ireland has a comparative advantage in the production of grass-based agricultural products (i.e. dairy, beef) compared to our continental European neighbours. The competitive advantage for producing energy crops within

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[21] Central Statistics Office. 2006. "Area, Yield and Production of Crops 2005."
[22] Assuming 4 tonne/hectare crop yield and 333 litres of cold pressed pure plant oil (PPO) per tonne of rape seed. 80,000ha×4t/ha×333lt/t = 106.56 million litres of PPO. The energy content of PPO at 33.7 MJ/ litre is just 4% less than the energy content of fossil diesel at 35.1 MJ/litre.
[23] Office of the Revenue Commissioners. "Statistical Report 2004."
[24] Rice. "Energy Crops - Have They a Future."
[25] Renou, Florence, Ted Farrell, Michael Keane, Gerry McNally, and John O'Sullivan. "Establishing a sustainable forest resource on industrial cutaway peatlands: tree performance and silvicultural techniques." *COFORD Connects - Silviculture and Forest Management Series No. 13*. COFORD.
[26] O'Carroll, Joe. 2005. "Introduction to Wood Biomass Potential in Ireland." *Seminar on Short Rotation Coppice - An Irish Oil Well?*: Hotel Minella, Clonmel, Co. Tipperary.
[27] Assuming a 10 tonne/hectare yield and 18 GJ/tonne energy content.

Ireland may also lie with grass rather than other crops, such as beet, willow or oilseed rape. Grass could be used as a component feedstock in an anaerobic digestion (AD) plant to produce biogas.[28] One advantage of grass as an energy crop compared to coppice willow or oilseed rape is that there is a high knowledge base relating to grass production. In addition the geographical distribution of lands suitable for grass production is much more dispersed than arable land (see Figure 2). The anaerobic digestion of grass would also require other feedstocks, of which there is a large supply (e.g. food processing and slaughter house wastes). The biogas produced could be supplied into the national gas network as a substitute for imported natural gas, whereas the digestate from the AD plant could be spread back on the same land from which the grass is harvested. The energy potential based on a grass feedstock could be very substantial and far exceed the energy potential of other energy crops. If just 5% of the land used for hay and silage production was used to produce grass as an anaerobic digestion feedstock the biogas energy potential from the grass feedstock alone could exceed the energy equivalent of approximately 262 million m^3 of natural gas.[29]

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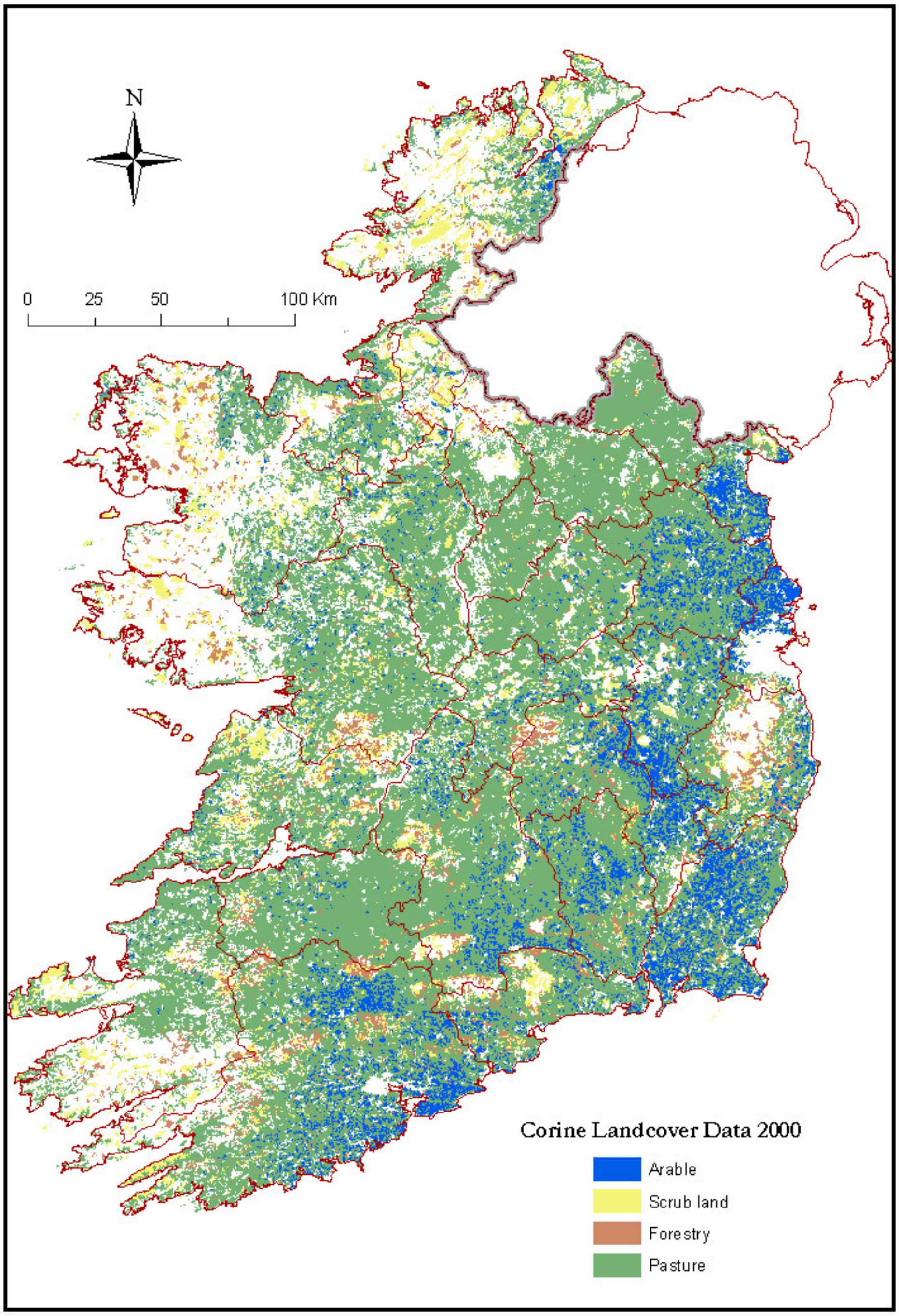
[28] One tonne of grass can yield in excess of 120 Nm^3 of methane with an energy content of roughly 4.5 GJ/tonne.

[29] This estimate is based on 5% of 1 million hectares of silage and 2.2 million hectares of pasture in 2004; 32 tonnes/hectare yield from silage grounds per annum (first and subsequent cuts) and 5 tonnes/hectare yield from other pastures.

Figure 2: Land Use in Ireland 2000



- **Dry Agricultural Residues**
  There are three main dry agricultural residues that have significant energy potential: straw, poultry litter, and spent mushroom compost. Sustainable Energy Ireland estimate that a total resource of 53.7ktoe of energy is potentially available for recovery from dry agricultural residues, which is

approximately equivalent in energy value to 60 million litres of kerosene.[30] This comprises some 133,000 tonnes/annum of straw with an energy equivalent of 42.8ktoe; some 25-40,000 tonnes/annum of poultry litter equivalent to 5.4-8.6ktoe; and some 62,000 tonnes of spent mushroom compost representing 4.7ktoe. The bulk of available poultry litter arises in Co. Monaghan, while the bulk of available spent mushroom compost arises in counties Monaghan, Cavan and Louth.

The analysis above clearly demonstrates that the national biomass energy resource is very substantial. The aggregate energy recovery potential highlighted above is equivalent to roughly 515 million litres of fuel and 262 million m^3 of natural gas equivalent (see Table 2). The estimates presented are based on a resource base that is practically accessible for bio-fuel production within the medium term. It is not an exhaustive estimate of the total biomass energy potential. In addition, a number of assumptions underlie the estimates. One assumption is that biomass energy recovery is profitable but at present this is generally not the case. A second assumption is that there is sufficient market demand for the energy products produced. Deficient demand could pose a significant problem as supplies expand. For example, the over-subscribed Mineral Oil Tax Relief Scheme exempts 6 million litres per annum of pure plant oil (PPO) but at present it is unrealistic to assume that there will be sufficient demand for 100 million litres of PPO as a substitute for diesel in the medium term. The reason for this that the use of PPO as a transport fuel is not as convenient as conventional fuels and additionally engine modification costing approximately €2000 is required. There are also compatibility problems for burning other fuel products (e.g. wood pellets) in existing fuel burners, which will lessen the economic incentive to switch to bio-energy fuels.

The production of bio-ethanol is also mooted as a potential bio-energy fuel. One of the advantages of ethanol is that it can be blended with petrol and does not require engine modification. Construction of a bio-refinery for ethanol production would require a large capital investment and therefore growth in bio-energy supply is more likely to arise from smaller scale and less complex fuels in the shorter term.

Table 2: Biomass Energy Resource

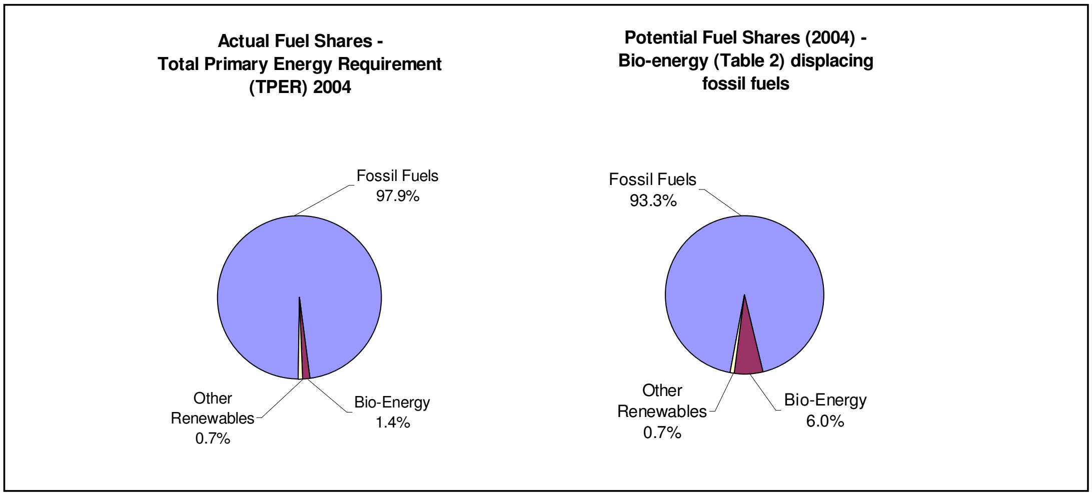
Biomass	Quantity	Energy Content - ktoe	Fossil fuel substitute	Fossil fuel substitute - millions
RVO/Tallow	55,000 tonnes	46	Diesel	51 litres
Forestry and wood sector biomass	500,000 tonnes	229	Kerosene	256 litres
Energy crops	80,000 hectares	86	Diesel	100 litres
Grass	162,000 hectares	245	Natural gas	262 m^3
Coppice crops	10,000 hectares	43	Kerosene	48 litres
Dry Agricultural residues	227,000 tonnes	56	Kerosene	60 litres
Total		706		

[30] Sustainable Energy Ireland. 2003. "An Assessment of the Renewable Energy Resource Potential of Dry Agricultural Residues in Ireland."

The total energy potential of 706ktoe in Table 2, while large, is still a relatively small share of total national energy consumption. Figure 3 shows a breakdown of fuel shares of the 2004 Total Primary Energy Requirement (TPER) when bio-energy fuels constituted just a 1.4% share. Had the 704ktoe bio-energy potential outlined in Table 2 been realised in 2004 the contribution of bio-energy to TPER would have been over four-fold higher at 6%. Figure 3 shows this graphically.

The European Environment Agency (EEA) recently estimated Ireland's 'environmentally-compatible' bio-energy potential at 1,100ktoe in 2010, which is of a similar order of magnitude as the 704ktoe estimated here.[31] However, the EEA is much less optimistic on the prospects for agriculture as a source of bio-energy with an estimate of approximately 100ktoe, which is roughly consistent with conventional bio-energy crops (e.g. oil seed rape) being the predominant energy source from agriculture.[32] As demonstrated above, the agriculture sector's contribution to bio-energy will be significantly greater if grass can be utilised for energy production.

Figure 3: Total Primary Energy Requirement 2004



The recovery of bio-energy involves significant energy consumption, therefore the figures overestimate the net energy gain. On the other hand the scenarios presented are not estimates of the maximum resource available, the actual bio-energy potential is much higher. Nonetheless the figures highlight what is a substantial, largely untapped, indigenous energy source. The recovery of bio-energy also affords other benefits. Environmental benefits include reduced emission of carbon dioxide via the displacement of fossil fuel consumption; while short rotation coppice is an ideal outlet for waste sludge as a fertiliser, subject to relevant regulations,[33] rather than disposal in landfills. The development of a bio-energy industry will also have socio-economic

[31] European Environment Agency. "How much bioenergy can Europe produce without harming the environment?"
[32] Energy from agricultural residues, such as animal slurries, are classified as being derived from waste.
[33] S.I. No. 148/1998: Waste management (use of sewage sludge in agriculture) regulations, 1998; S.I. No. 267/2001: Waste management (use of sewage sludge in agriculture) (amendment) regulations, 2001; and Department of Environment, Heritage and Local Government. 1999. "Code of Good Practice for the use of Biosolids in Agriculture – Guidelines for Farmers." Department of Environment, Heritage and Local Government.

benefits; supporting employment in the production, collection and processing of bio-energy products. Many of these environmental and socio-economic benefits are not incorporated into investment appraisal decisions though government supports are one way to internalise such benefits into that decision process.

Exchequer Implications

Bio-fuels are subject to the same excise provisions as fossil fuels but due to their relatively higher production costs bio-fuels are generally more expensive than competitor fossil fuels. One measure to improve bio-fuel price competitiveness is the Department of Communication, Marine and Natural Resources' Mineral Oil Tax Relief scheme, which is providing over €6m in excise relief on 16 million litres of biofuels produced within eight specific projects over a two-year period commencing in 2005. In December 2005 the Department of Communication, Marine and Natural Resources (DCMNR) announced that further schemes would be launched during 2006 costing €200 million over 5 years.

Excise exemption schemes can have a significant impact on the price competitiveness of bio-fuels. Excise duty on transport fuels (e.g. petrol, etc.) varies from €0.36805 to €0.44268 per litre and could represent as much as 40% of the market retail price of fossil fuels and therefore represents a significant support measure for bio-fuels.[34] The DCMNR's proposed €200 million 5-year support scheme for bio-fuels could exempt some 100 million litres per annum, which represents approximately 2% share of the transport fuel market.

If the DCMNR's new proposal also incorporates non-transport bio-fuels it is not clear that excise exemption alone will be sufficient to make non-transport bio-fuels price competitive. For liquid bio-fuels the excise exemption would equate to approximately 8% of the retail price of home heating oil, which is a significant subsidy in itself but may not be sufficient to make liquid bio-fuels price competitive compared to kerosene.[35] Bio-fuels such as wood chips and pellets are not subject to excise duty and in such instances other mechanisms may be necessary to promote demand.

Potential Bio-energy Demand

Demand for energy is continually growing. Growth in total final energy consumption averaged 2.7% per annum between 2000 and 2004.[36] But even with such growth the bio-energy market faces several obstacles and uncertainties as it attempts to expand. The most significant challenge facing the bio-energy sector is establishing credibility for bio-fuel as a value for money, quality alternative to fossil fuel. A long term and targeted strategy will be necessary to overcome the dominant position of fossil fuels, upon which there is 97% reliance nationally. The dominance of fossil fuels is reinforced by the fact that most fuel consuming equipment is engineered for fossil

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[34] Excise duty on transport fuels is as follows: €0.44268 per litre of petrol; €0.42044 per litre of heavy fuel oil used as propellant; €0.36805 per litre of mineral oil substitute fuels used as a propellant.

[35] Excise duty on mineral oil substitute fuels for non-transport purposes is €0.4736 per litre. Based on a price of €0.589 retail price of kerosene (incl. VAT) in January 2006 (source SEI) an excise exemption of €0.4736 on bio-fuel is equivalent to 8% of the retail price. Excise duty on gas oil is €0.4736 per litre and €0.3174 per litre of kerosene.

[36] Howley, Martin, Fergal O'Leary, and Brian Ó Gallachóir. 2006a. "Energy in Ireland 1990-2004 Trends, Issues, Forecasts and Indicators." Sustainable Energy Ireland

fuel, which creates inertia for consumers that might otherwise be inclined to utilise bio-fuels.

A competitive market price for bio-fuels is critical for the development of a bio-energy market. Consumers will not switch to bio-fuels to any significant extent unless bio-fuels are priced at a significant discount to fossil fuels. For example, the current excise exemption on transport bio-fuels enables producers to price at a discount to fossil diesel and win market share. Even in the absence of subsidies for solid bio-fuels some bio-fuels are already competitively priced and gaining market share but circumstances vary by energy source, fuel product and location. For example, available data suggests that wood pellets are competitively priced compared to home heating oil.[37]

Fuel price competition is only one element of the economics of switching to bio-energy fuels. Additional capital costs also arise because most vehicles and boilers are designed for fossil fuels and must be adapted if bio-fuels are used.[38] Additional capital costs also arise when purchasing new equipment, as bio-fuel equipment is often more expensive. Therefore, as bio-fuelled engines and boilers involve higher capital expenditures, the economic incentive to switch to bio-fuels depends on the discounted total cost (capital plus running cost). That is, it depends on whether a bio-fuel system with a higher initial capital cost and lower running cost is less expensive than a fossil fuel system with a lower capital cost but higher running cost. Financial incentives to promote bio-energy systems attempt to tip the balance in favour of bio-fuel systems either via capital grants or subsidies on running costs. However, it is also important that the public is encouraged to focus on the longer time horizon and evaluate purchases of energy systems (incl. vehicles) on costs over the lifespan of the product.

The potential demand for bio-fuels is high but without consumer incentives growth in the market will be slow. The most opportune time for switching to bio-fuels is when either existing equipment is being replaced or when new equipment is being purchased, therefore, incentive measures are likely to be most successful when targeted at consumers purchasing equipment. In addition, given the current high volume of construction, measures targeted at new buildings could make a significant impact within a relatively short period. For instance, over 18.7 million m^2 of new floor area received planning permission covering dwellings, commercial, and other buildings in 2004.[39] If just 20% of one year's new houses adopted bio-fuel heating systems (e.g. wood pellets) additional demand for wood pellets could exceed 50,000 tonnes per annum, which is equivalent to the total capacity at the leading pellet manufacturer on the island.[40]

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[37] Based on Sustainable Energy Ireland's monthly domestic fuel price comparison the relative energy cost of kerosene was €15.72/GJ, bagged wood pellets €16.18/GJ, and bulk wood pellets €12.14/GJ in January 2006

[38] Bio-fuels such as bio-diesel and ethanol do not require adaptation of equipment, however, their production involves a higher level of processing and the fuels are usually more expensive.

[39] CSO 'Planning Permission' Releases

[40] Balcas Timber Ltd, Co. Fermanagh (www.balcas.com) has built a wood pellet production facility with a capacity of 50,000 tonnes per annum.

Aside from price there are several important considerations for consumers contemplating a switch to bio-fuel. If households and businesses invest in bio-fuel equipment can they be guaranteed that supplies will meet growing demand? Will bio-fuel supplies be conveniently available? Will domestic bio-fuel supply deficits be supplemented by bio-fuel imports? Will there be a convenient national transport bio-fuel distribution network or will motorists have to make special fuel arrangements when travelling away from their local fuel source? None of these questions raise insurmountable obstacles for the development of bio-fuels in Ireland, however, without a strong level of certainty in many aspects of the market, growth of bio-fuels will remain slow and haphazard. Among the supports necessary for the bio-fuel sector are measures to rapidly build a critical mass in the bio-fuel market, which will in turn alleviate uncertainties and consumer hesitation to switch to bio-fuels.

Discussion

The synergies between the bio-energy and waste management sectors could deliver many environmental quality improvements. The EPA is keen to see that such benefits are realised and therefore would support measures that assist in the development of the bio-energy sector.

Government waste management policy[41] aims to divert biodegradable municipal waste from landfill, which is also a requirement of EU legislation.[42] Landfill disposal of most biodegradable waste, whether municipal and otherwise, is an inefficient use of scarce landfill space. Biodegradable material is a resource that can, in many instances, be further processed into valuable commodities; compost and energy are two examples. Large quantities of biodegradable materials could be utilised as a feedstock for the bio-energy sector rather than processed as waste. For example, municipal waste still comprises some 14,000 tonnes of wood and large volumes of cooking oils.[43] Utilisation of such biodegradable materials as energy feedstock would contribute to national waste policy targets of increased recovery of waste and diversion from landfill.

The management of waste sludge is posing an increasingly difficult problem for waste management. The quantity of sludge from wastewater treatment plants has increased considerably in recent years with the construction of new treatment plants. In addition many industrial production processes produce waste sludge, e.g. dairy processors. The primary disposal options for sludge are landfill or land-spreading but many landfills no longer accept sludge, whereas regulations governing spreading of sludge on agricultural lands effectively limit the area of land available for environmentally sound disposal. The regulations in part are a disease control measure to avoid contamination of animal or human feedstuffs.[44] Agricultural land used for

[41] Department of Environment, Heritage and Local Government. 2006. "National Strategy on Biodegradable Waste." Department of Environment, Heritage and Local Government, Custom House Quay, Dublin 1

[42] ‘Landfill Directive’ 1999/31/EC.

[43] Collins, Caitríona, Odile Le Bolloch, and Brian Meaney. 2005. "National Waste Report 2004." Environmental Protection Agency

[44] S.I. No. 148/1998: Waste management (use of sewage sludge in agriculture) regulations, 1998;

energy production, e.g. coppice willow, would largely be exempt from the disease control elements of the regulations and therefore would offer an ideal location for managing sludge and for utilising the sludge's nutrients as a fertiliser.

Though energy crops may have a high nutrient demand it is important that fertiliser application is undertaken mindful of crop needs, as over application of fertiliser will potentially impact ground or surface water quality. Farmers have a good understanding of the nutrient demands for conventional crops but there is a lower knowledge base on the requirements of some energy crops, such as coppice willow for example, therefore it is important that energy crop producers educate themselves in this regard. In addition, it is important that nutrient management plans are devised and that the nutrient content of all fertilisers, including slurries and sludge, is known. Not all sludge is suitable for land-spreading, e.g. drinking water treatment plant sludge, therefore sludge introduced onto farmland should be tested for its nutrient content and suitability for land spreading.

As highlighted earlier, residual material from forestry operations (i.e. tree branches and tops) has a high energy potential. Whether such materials are recovered will depend on the financial cost of collection and processing, however, there is also a potential environmental cost to be considered. The Forest Service has developed a series of codes of practice that include measures to minimise the environmental impacts of forestry operations but the recovery of forestry residuals may create further environmental impacts, for example, relating to soil erosion or biodiversity. The collection of forestry residuals should be undertaken by methods that minimise environmental damage.

EU agricultural policy and World Trade Organisation (WTO) negotiations are forcing changes in Irish agriculture, for instance, the decline in stock numbers and discontinuation of sugar beet production. These changes create an opportunity for the bio-energy sector to utilise land that was previously used for either animal or crop production. The choice of suitable energy crop will vary by location, however, the country is particularly suited for grass production. Grass for energy production is likely to be particularly suited to existing farming systems, availing of silage storage space for example, and would have a relatively low establishment cost compared to other energy crops. Unlike other bio-fuels there is already a large existing market for biogas. Cleaned and filtered biogas could be supplied into the natural gas network and be easily accessible to all natural gas customers.

Several bio-energy fuel products are currently available on the Irish market and a number of different agents are involved in fuel production and supply. With a number of producers, and without any bio-mass fuel standards, there will invariably be differences in fuel quality and specification. In the absence of fuel standards consumers have no independent guarantee of the quality of fuels purchased. Nor are producers compelled to supply fuels to a particular quality. If consumers are unsatisfied with the quality of fuels (e.g. high moisture wood chips, impurities in PPO) they are likely to revert to fossil fuels. Without bio-fuel standards there is a risk

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S.I. No. 267/2001: Waste management (use of sewage sludge in agriculture) (amendment) regulations, 2001; and Department of Environment. "Code of Good Practice for the use of Biosolids in Agriculture – Guidelines for Farmers."

that the general public will develop a view that bio-fuels are inferior to fossil fuels, especially if poor quality bio-fuels are supplied onto the market. If such a situation arises the prospects for market development would be irreparably damaged. It is important therefore that national standards are adopted for the different bio-fuel products.

Though bio-energy crops may be carbon-dioxide neutral they are not necessarily environmentally 'clean'. The EU is developing its first pollution standards for fine particulate matter (PM2.5) due to concern of the level of air pollution from domestic sources. Germany's environment agency, for example, has already called on its government to impose stronger emission controls on small wood burning stoves. In Finland, where firewood and wood-pellets are widely used, the government is also moving towards developing emission standards for boilers and fireplaces.

Summary

The aim of this paper was to focus attention on bio-energy within the wider public policy discussion on renewable energy. All forms of renewable energy have a role to play in reducing our reliance on fossil fuels, which is currently 97%. Increasing our use of renewable energy affords benefits in terms of improved energy security of supply, and environmental benefits particularly with respect to emissions to air but bio-energy also affords additional benefits, including waste management and biodiversity benefits. If bio-fuels are produced indigenously, rather than imported, there are also potential socio-economic benefits.

Among the EU's energy targets are that the EU achieve a 12% overall share for renewable energy by 2010, which will require bio-energy's contribution to at least double.[45] This paper presents estimates of the bio-energy resource that might be practically accessible in the medium term and finds that it is feasible for Ireland to double bio-energy's contribution to total energy requirements. However, there are many hurdles to overcome before such a target will be achieved. The ability of bio-fuel producers to supply a price competitive product to the market is a significant challenge and will be a necessary condition for bio-energy markets to prosper. Many of the sector's other hurdles are similar to those facing any new product trying to capture market share in a well-established market where consumers have strong links with existing products. Many new product launches ultimately fail because a critical demand level is not achieved, which is necessary to generate production economies of scale, and a resultant competitive cost structure. Bio-energy fuels will face the same obstacles and because bio-energy has many environmental benefits government support to the sector is important to ensure that bio-fuels establish a strong initial foothold in the market.

At present there are a number of schemes providing financial support to the bio-energy sector. The government has also announced that it intends to bring forward a package of measures during 2006. The proposed package will include excise tax relief; a financial package for wood chip and pellet boilers aimed at the non-residential sector; grants for householders for the installation of renewable energy

[45] COM(2004) 366

technologies; and grant aid supporting the installation of combined heat and power systems.[46] These measures are a welcome support to the renewable and bio-energy sectors. The decision to switch to bio-fuels is affected by both the capital equipment and fuel cost and where these costs represent obstacles to the decision to switch to bio-fuels it is important that support schemes generate a reasonable incentive to switch.

The development of bio-energy has the potential to deliver benefits for the environment and consequently the EPA would like to see the sector grow. Some bio-energy projects (e.g. coppice willow, anaerobic digestion, waste biomass recovery) could also make a significant contribution towards the efficient and environmentally sound management of waste. Government support is necessary to achieve expansion in the bio-energy sector and that support is likely to deliver dividends for waste management in addition to energy and environmental benefits. However, all bio-energy projects will not necessarily be worthwhile from an energy perspective but in such cases the environmental benefits might tip the balance in favour of undertaking the project.

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