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A biofuel strategy for Ireland with an emphasis on production of biomethane and minimization of land-take

Anoop Singh [a,b], Beatrice M. Smyth [a,b], Jerry D. Murphy [a,b,*]

[a] Department of Civil and Environmental Engineering, University College Cork, Cork, Ireland
[b] Biofuels Research Group, Environmental Research Institute, University College Cork, Cork, Ireland

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ABSTRACT

Increasing energy consumption has exerted great pressure on natural resources; this has led to a move towards sustainable energy resources to improve security of supply and to reduce greenhouse gas emissions. However, the rush to the cure may have been made in haste. Biofuels in particular, have a bad press both in terms of competition with good agricultural land for food, and also in terms of the associated energy balance with the whole life cycle analysis of the biofuel system. The emphasis is now very much on sustainable biofuel production; biofuels from wastes and lignocellulosic material are now seen as good sustainable biofuels that affect significantly better greenhouse gas balances as compared with first generation biofuels. Ireland has a significant resource of organic waste that could be a potential source of energy through anaerobic digestion. Ireland has 8% of the cattle population of the EU with less than 1% of the human population; as a result 91% of agricultural land in Ireland is under grass. Residues such as slurries and slaughter waste together with energy crops such as grass have an excellent potential to produce biogas that may be upgraded to biomethane. This biomethane may be used as a natural gas substitute; bio-compressed natural gas may then be an avenue for a biofuel strategy. It is estimated that a maximum potential of 33% of natural gas may be substituted by 2020 with a practical obtainable level of 7.5% estimated. Together with biodiesel from residues the practical obtainable level of this strategy may effect greater than a 5% substitution by energy of transport. The residues considered in this strategy to produce biofuel (excluding grass) have the potential to save 93,000 ha of agricultural land (23% of Irish arable land) when compared to a rapeseed biodiesel strategy.

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Abbreviations: AD, anaerobic digestion; CAD, centralised anaerobic digestion; CH_4, methane; CO_2e, carbon dioxide equivalent; DS, dry solids; GDP, gross domestic product; GHG, greenhouse gas; NCCS, National Climate Change Strategy; OFMSW, organic fraction of municipal solid waste; UCO, used cooking oil; VDS, volatile dry solids.

* Corresponding author at: Department of Civil and Environmental Engineering, University College Cork, Cork, Ireland. Tel.: +353 21 4902286; fax: +353 21 4276648.
E-mail address: jerry.murphy@ucc.ie (J.D. Murphy).

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1. Introduction

Sustainable development is a term that is now very trite in a number of waste management, energy generation and rural development plans [1]. Renewable energy sources have been growing in importance in the European and global energy markets due to various benefits associated with their use viz. decreasing import dependency, diversifying sources of production, and contributing to sustainable development [2]. A considerable reduction in energy dependency and carbon emissions could be achieved by using biofuels from organic waste.

1.1. Greenhouse gas targets

The European Commission (EC) proposed new emissions targets for 2020 in 2008/0014 (COD), dated 21/01/2008. These targets are proposed to replace the Kyoto targets when they expire in 2012; for Ireland this target is 20% less emissions relative to 2005 by 2020 [3]. Ireland has faced incredible difficulty in attempting to meet the Kyoto target which allowed a 13.5% increase in greenhouse gas (GHG) emissions above 1990 levels in the first commitment period (2008–2012). At present Ireland's GHG emissions stand at about 26% above the 1990 level [4].

1.2. Sustainability of biofuels

Sustainability of biofuels has come under scrutiny in the past years [5–8]. Fig. 1 highlights a comparative energy balance which indicates the relative gross and net energy production per hectare for various biofuel systems. It may be noted that traditional European indigenous biofuel systems (ethanol from wheat and rapeseed biodiesel) do not fare as well as tropical biofuel systems such as palm oil biodiesel. Biogas from grass may however be deemed a good biofuel as it generates an equivalent energy to palm oil biodiesel and does not threaten sensitive ecosystems. The EU responded with the Renewable Energy Directive [9] which stipulated that biofuels need to meet two criteria to be classified as biofuels after 2010, namely:

- To achieve a greenhouse gas emissions saving of at least 35% compared with the fossil fuel they replace on a life cycle analysis basis;
- not to be made from land with recognised high biodiversity value or high carbon stock.

The Directive [9] attributed some default values to biofuel systems, some of which are outlined below:

Wheat ethanol (process fuel not specified)	0%
Wheat ethanol (natural gas process fuel)	33%
Rapeseed biodiesel	36%
Palm oil biodiesel (process with no methane emissions to air at oil mill)	55%
Waste vegetable or animal oil biodiesel	77%
Biogas (as compressed biomethane) from various residues	75–85%

Thus the benefit of biogas and biodiesel when generated from residues such as the organic fraction of municipal solid waste (OFMSW) and agricultural residues is quiet obvious.

1.3. Biofuels from waste

Major economies are relying on biofuels as part of their strategies to reduce GHG emissions and energy dependency. For Ireland, biofuels from wastes can play an important role in improving the balance of trade by reducing imports of increasingly expensive fossil fuels. Unlike other renewable energy sources, the production and use of biofuels is relatively labour-intensive and can also potentially play a positive role in maintaining and developing the rural economy. Environmental pollution from municipal, industrial and agricultural operations/wastes continues to grow. The concept of the 'four R's', Reduce, Reuse, Recycle and Renewable energy, has generally been accepted as a useful principle for waste handling [10]. Municipal, industrial and agricultural wastes contain organic substances with significant energy potential that can be used efficiently with the help of technologies, such as anaerobic digestion (AD). This will provide the dual benefits of delivering energy and also protecting the environment.

1.4. Anaerobic digestion (AD)

Anaerobic digestion is an appropriate technique for converting organic wastes (slaughterhouse waste, agricultural slurries, the organic fraction of municipal solid waste, etc.) and wet biomass such as ensiled energy crops, into renewable energy. Digestion of organic wastes yields a substance that has a lower pollution