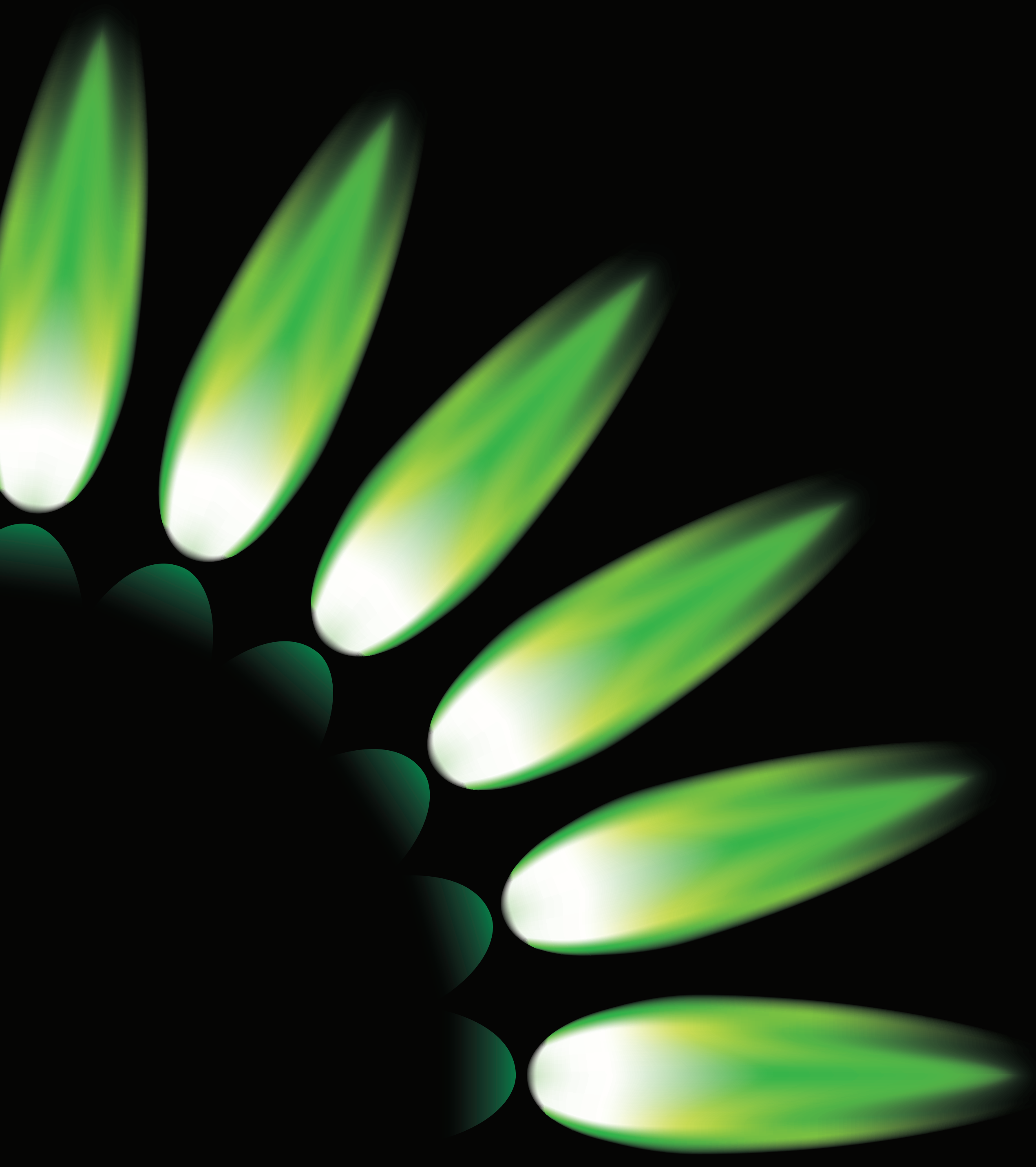
BORD GÁIS

THE FUTURE OF RENEWABLE GAS IN IRELAND



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INTRODUCTION FROM CEO

Bord Gáis recognises the significant challenges posed by the ambitious EU and Irish renewable energy targets in electricity, heat and transport. As an organisation, we have clearly demonstrated our commitment to contribute towards meeting those targets via our investment in wind assets and high efficiency power generation equipment. In 2008, we established a €10 million Alternative Energy Research and Development Fund to support research into emerging energy-related technologies and to support an increase in the quantity and quality of research in alternative energies in Ireland's colleges. In further recognition of the importance of renewable energy as part of a sustainable future for this country, Bord Gáis has commissioned this report 'The Future of Renewable Gas in Ireland'.

WE BELIEVE THAT RENEWABLE GAS REPRESENTS A SIGNIFICANT AND UNDER-UTILISED SOURCE OF RENEWABLE ENERGY

The report examines the production and use of biomethane as a renewable energy source in Ireland and its potential contribution to assist in meeting Ireland's renewable energy targets. The report outlines the potential benefits associated with developing this renewable fuel source as well as the barriers that must be overcome to make renewable gas a reality.

We believe that renewable gas represents a significant and under-utilised source of renewable energy in Ireland and could make a significant contribution to Ireland's renewable energy and waste objectives in the future. The production of grid quality biomethane or renewable gas can play a vital role in helping Ireland to attain its renewable energy targets, in addition to a variety of other benefits outlined in the report. The fact that biomethane can be transported using the readily available natural gas infrastructure, to over 640,000 homes and businesses throughout the country, represents a significant advantage. Many other countries in Europe have recognised the value of renewable gas and are putting the necessary structures in place to support the industry e.g. Germany and Sweden.

Undoubtedly, there are obstacles to making renewable gas a viable energy source in Ireland. However we believe if the necessary parties work together, these barriers can be overcome in a relatively short timeframe. We are willing to work with the relevant authorities to ensure that the necessary structures are put in place. We welcome the support of industry, the Sustainable Energy Authority of Ireland (SEAI), the Environmental Protection Agency (EPA) and other relevant parties in the publication of this report and we look forward to working with all policy makers in the development of a renewable gas industry in Ireland.

John Mullins,
CEO, Bord Gáis

01.

EXECUTIVE SUMMARY

The EU and the Irish Government have set bold renewable energy, environmental and waste management targets for Ireland, but renewable energy currently accounts for only around 4% of Ireland's total gross final energy demand. Obviously something needs to be done to address this shortfall. The EU has highlighted the sustainability of renewable gas systems and has encouraged Member States to take measures to support the wider use of renewable gas. In Ireland, there is a large resource available for the production of renewable gas and, if captured and utilised efficiently, it could represent a significant opportunity to help achieve these challenging renewable energy targets.

CAPTURING THIS RESOURCE WOULD BE A CONSIDERABLE STEP IN ADDRESSING IRELAND'S CHALLENGING RENEWABLE ENERGY TARGETS

This paper, commissioned by Bord Gáis, investigates the potential for producing biomethane in Ireland, assesses its potential contribution to achieving Ireland's renewable energy targets and includes a qualitative discussion on the potential benefits and barriers to using biomethane as a source of heating and transport fuel in Ireland. The report highlights that energy from biomethane has the potential to contribute significantly to Ireland's renewable energy targets. In particular biomethane could greatly assist Ireland in meeting the EU targets for thermal energy from renewables (RES-H) and transport fuel from renewables (RES-T).

Biogas is produced when feedstocks, such as organic wastes (agricultural and municipal), and energy crops, such as grass silage, are converted into biogas using anaerobic digestion technology. The 'raw' biogas can be cleaned and upgraded into biomethane (renewable gas) and injected into the national gas grid to be used as a heating fuel in homes and businesses. A conservative estimate of the potential biomethane resource in Ireland is 0.4 billion m^3/a or 7.5% of the national gas demand requirement (the equivalent of heating 300,000 homes each year). Capturing this resource would be a considerable step in addressing Ireland's challenging renewable energy targets and help reduce the country's dependency on energy imports.

Biomethane production could also provide an environmentally sound waste management option, helping Ireland to meet EU Landfill Directive requirements, thereby reducing the overall cost of waste management in Ireland today. Other benefits from the development of a biomethane infrastructure might include income and job security for farmers and job creation in the construction and operation of biomethane plants. A biomethane infrastructure could make a significant contribution to the 'green tech' sector in line with Ireland's strategy to create sustainable knowledge-driven industries.

Undoubtedly work still needs to be done to make biomethane a viable energy option for Ireland. However, most of the obstacles identified in this report could be resolved relatively quickly with the support of Government and the relevant regulatory bodies. The following recommendations should be considered by policy makers to encourage biomethane production in Ireland:

- Set national targets for a proportion of gas demand to be met from biomethane.
- Review the Renewable Energy Feed-in Tariff (REFIT) to support biomethane fed directly into the natural gas grid. The new tariff could be in line with the support structure used in Germany.
- Implement regulatory conditions to allow biomethane producers to inject biomethane directly into the gas grid and adopt suitable standards that will regulate the quality of biomethane that may be injected into the gas grid. Such standards will deal with gas specifications such as chemical composition and energy content.
- Implement new support structures for agriculture to provide an incentive for farmers to produce feedstock for biomethane production.
- Align renewable energy and waste management policies to deliver certainty around feedstock supply over the life of the biomethane plant.
- More funding for research, development and demonstration of renewable gas technologies, building upon the existing expertise in biotechnology and information technology.

02.

INTRODUCTION

Ireland has enjoyed substantial economic growth in the past 15 to 20 years and this has been accompanied by commensurate growth in energy demand.

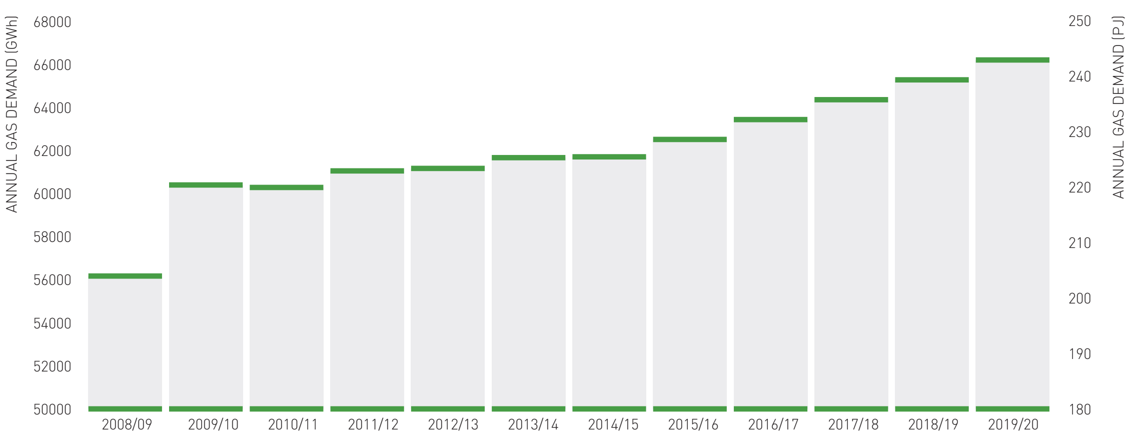
THERE IS A NEED TO FIND ALTERNATIVE, SUSTAINABLE AND RENEWABLE ENERGY SOURCES

The above-inflationary growth in total primary energy consumption (total growth of 72% from 1991 to 2008) has magnified some of the existing characteristics of the Irish energy system – high energy imports and growing greenhouse gas (GHG) emissions.[1-2]

An increased reliance on gas in the economy, the absence of sufficient domestic reserves, concerns for the environment and an increase in electricity and gas prices have driven the need to find alternative, sustainable and renewable energy sources.

Current estimates[3] indicate that the near term demand for gas in the power, residential, commercial and industrial sectors is expected to increase by about 6,000GWh by 2020 compared to the current level of 60,000GWh. **Figure 1** shows the forecast gas demand up to 2020.

Figure 1: Gas demand projection in the Republic of Ireland



Source: Annual gas demand forecasts up to 2014/15 were provided by Gaslink. The annual change in gas demand after 2014/15 was calculated using the average annual increase/decrease in gas demand between 2008/09 to 2014/15.

03.

RENEWABLE ENERGY IN IRELAND

The White Paper published in March 2007 sets out the Government's Energy Policy for 2007 to 2020.

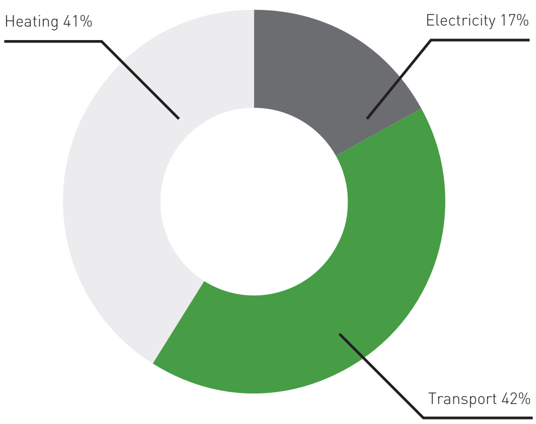
RENEWABLE ENERGY HAS GROWN CONSIDERABLY IN ABSOLUTE TERMS SINCE THE MID-1990s

The Government has set targets for:

- At least 15% and 33% of electricity to be generated from renewable sources by 2010 and 2020 respectively. The 2020 target was subsequently extended to 40% in the Carbon Budget of October 2008.[4]
- A minimum of 5% and 12% renewable energy share of the heating sector for 2010 and 2020[5] respectively.
- Renewable resources to contribute at least 10% of all transport fuel by 2020.

Renewable energy has been contributing approximately 2% of Ireland's energy supply since 1990. In 2008 renewable sources contributed 4% of Ireland's gross final energy use. The significant increase in energy demand over that time masks the fact that renewable energy has grown considerably in absolute terms since the mid-1990s. The contribution from renewable energy grew by over 247% (7.1% per annum) between 1990 and 2008.[6]

Figure 2: Energy use in Ireland by mode of application 2008



Source: Energy in Ireland 1990-2008, Energy Policy Statistical Support Unit, the Sustainable Energy Authority of Ireland (SEAI).

Ireland is making progress in relation to its renewable energy sourced electricity (RES-E) target: 11.8% of total electricity consumed in 2009 came from renewable energy sources, up from 4.4% in 2003.

By 2009, wind accounted for 11% of electricity in Ireland.[7] In May 2008, the Economic and Social Research Institute (ESRI) stated that the amount of electricity generated from wind could reach 30% by 2020,[8] making a significant contribution to the new 40% RES-E target under the Carbon Budget set in October 2008.

Figure 2 shows the final energy use in Ireland broken down by application. The share of energy used for heating and transport has historically been overlooked by renewable energy policy, despite final energy demand for both heating and transport in Ireland being significantly higher than that for electricity.[9] By 2008, however, only 3.6% of thermal energy was generated from renewable sources (compared with 11.9% for electricity).[10]

04.

BIOMETHANE RESOURCES AND MARKET POTENTIAL

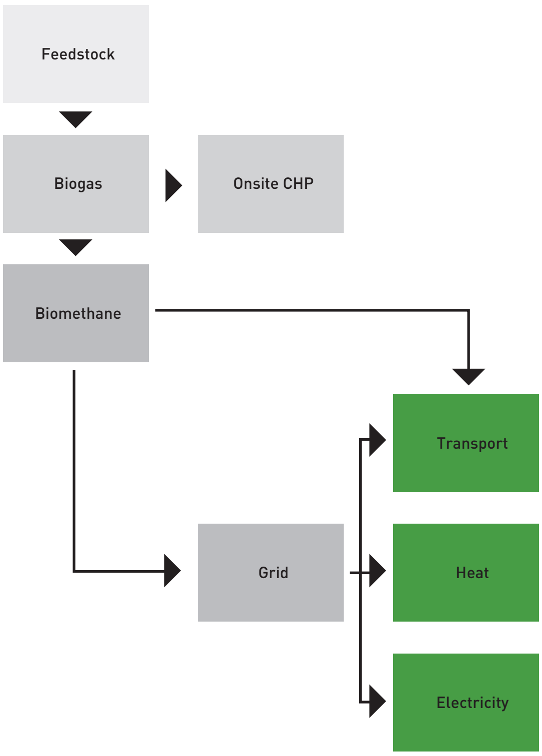
Biogas production occurs when biomass is broken down into simpler chemical components, typically using anaerobic digestion (AD) technology.

IRELAND HAS SIGNIFICANT UNEXPLOITED POTENTIAL FOR BIOMASS IN THE FORM OF AGRICULTURAL LAND AND RECYCLED WASTE

AD technology involves a natural process of decomposition in the absence of oxygen. It is a proven technology that has been in use since 1895 when biogas was recovered from a sewage treatment plant and used to fuel street lamps in Exeter, England.[11] The decomposition process produces a 'raw' biogas, comprising methane and carbon dioxide, in addition to a semi-solid digestate residue product. Raw biogas can be used on-site to produce heat and electricity or upgraded to biomethane and injected into the natural gas network, or used as a transport fuel.[12]

Biogas upgrading involves cleaning and purifying the raw biogas to meet a specification akin to natural gas. The main purpose of the upgrading is to remove gases such as carbon dioxide (CO_2) and hydrogen sulphide (H_2S), and eliminate or reduce contaminants. Biomethane injected into the grid can generate significantly more energy off-site where its use can be optimised by using it for heat, Combined Heat and Power (CHP), or transport fuel rather than on-site electricity generation only.[13] **Figure 3** illustrates the various uses of biogas.

Figure 3: Uses of biogas



Ireland has significant unexploited potential for biomass in the form of agricultural land and recycled waste from municipal, agricultural and industrial sources. In 2007, Ireland produced about 40 million tonnes of biodegradable wastes (i.e. slurry, slaughter waste and organic household waste) suitable for anaerobic digestion.[14] In addition, Ireland has significant unexploited resource potential in the form of grass, with 91% of agricultural land, or 3.9 million hectares, being used to grow this potential energy crop.

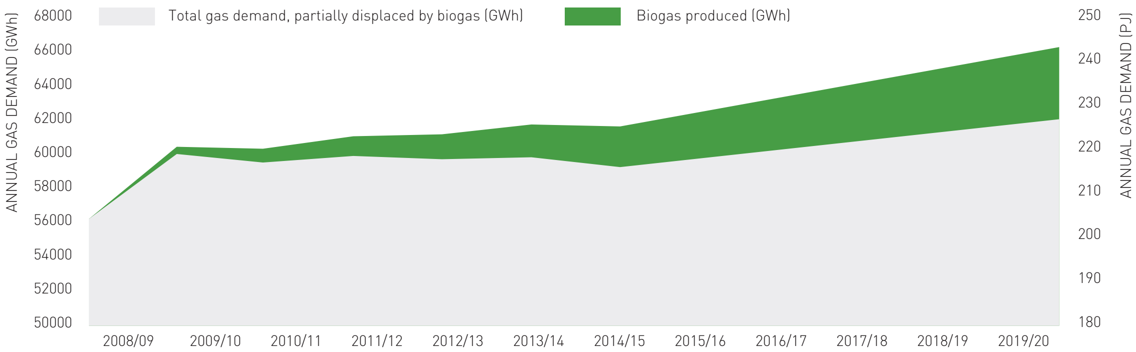
05.

POTENTIAL OF BIOMETHANE IN IRELAND

Research, sponsored by Bord Gáis, has been carried out on the availability of different feedstock for anaerobic digestion at University College Cork.[15] This analysis provided both a 'technical' and a 'baseline' potential for each feedstock in 2020.

BIOMETHANE COULD MAKE A SIGNIFICANT CONTRIBUTION TO IRELAND'S RENEWABLE ENERGY AND WASTE OBJECTIVES IN THE FUTURE

Figure 4: Fossil fuel based natural gas displacement by biogas



Source: Annual gas demand forecasts up to 2014/15 were provided by Gaslink. The annual change in gas demand after 2014/15 was calculated using the average annual increase/decrease in gas demand between 2008/09 to 2014/15.

The technical potential represents the maximum volume of biomethane that could be produced if the entire quantity of available feedstock in Ireland were used to produce biomethane. The baseline potential considers a scenario where a realistic proportion of the feedstock is diverted to biomethane production. This is based on 5% of cattle, pig and sheep slurry, 75% of poultry slurry, 50% of slaughter waste and 25% of the organic fraction of municipal solid waste (OFMSW).[16] Surplus grass in the baseline scenario equates to approximately 100,000 ha.[17] The results of this analysis are set out in **Table 1**.

Under the technical scenario there is the potential to meet 33.2% of Ireland's current natural gas demand, or 11.4% of total final energy demand with biomethane by 2020. Our mandatory target under EU Directive 2009/28/EC is to achieve 16% renewable energy penetration by 2020. Under the baseline scenario there is the potential to meet 7.5% of Ireland's current natural gas demand, as shown in **Figure 4**, or 2.6% of total final energy demand with biomethane by 2020. This is equivalent to 7.4% of Ireland's thermal energy demand in 2020 and indicates that biomethane could make a significant contribution to Ireland's renewable energy and waste objectives in the future.

Table 1: Total energy potential of waste and surplus grass in Ireland for 2020

	Technical potential		Baseline potential	
	Biomethane	Energy[e]	Biomethane	Energy[e]
Source	Mm^3/a	PJ	Mm^3/a	PJ
Agricultural slurry	423.8[a]	15.53	51.3	1.88
OFMSW	61.7	2.26	15.6[b]	0.57
Slaughter waste	37.4[c]	1.37	18.6	0.68
Surplus grass	1,298.3	47.58	325.7[d]	11.9
Total	1,821.2	66.74	410.2	15.03
% of total current Irish gas demand		33.2%		7.5%
% of 2020 final energy demand in white paper scenario		11.4%		2.6%

Source: Adapted Singh A, Smyth BM, Murphy JD, Renewable and Sustainable Energy Review, Volume 14, Issue 1, January 2010, Pages 277-288.
Notes:
a. 32,000,000 tonnes agricultural slurry x 12.8m^3 methane (CH_4) per tonne x 1/0.97= 423.8 Mm^3 biomethane per annum (with 97% CH_4 content).
b. 870,000 tonnes OFMSW x 25% recoverable x 69 m^3 CH_4 per tonne x 1/0.97= 15.6 Mm^3 biomethane per annum.
c. 420,000 tonnes slaughter waste x 86 m^3 CH_4 per tonne x 1/0.97= 37.4 Mm^3 biomethane per annum.
d. 97,500 hectares x 3,240 m^3 CH_4 per hectare x 1/0.97 = 325.7 Mm^3 biomethane per annum.
e. Conversion assumes biomethane has an energy content of 36.8 MJ/Mm^3

05.

05.1 ECONOMICS

The production of biomethane requires significant capital expenditure, as with all energy infrastructure, and relies on a long-term revenue stream to make a return on this investment. Where biogas is used in electricity production, these facilities benefit from a feed-in tariff under Ireland's REFIT scheme. Biomethane, however, would not directly benefit from this tariff, relying instead on the sale of the gas at market rates (such as wholesale gas prices) and possibly gate fees (fees which would be paid by feedstock suppliers).

The natural gas infrastructure is extensive, providing energy to over 640,000 domestic, industrial and commercial customers in Ireland. The fact that the distribution system is already built represents a significant advantage to biomethane over other renewable heat technologies.

The cost of producing biomethane from farm-based feedstocks (such as slurries, which do not attract gate fees, and grass, which requires purchase) ranges from around 10c/kWh to 20c/kWh depending on the feedstock, the scale of operation and the technology provided. Research carried out in 2008 by the Environmental Research Institute (ERI) at University College Cork indicates that the cost of heating buildings already connected to the natural gas network with a blended fuel (12% biomethane, 88% natural gas) may not be significantly more expensive than natural gas. The high cost of producing biomethane is buffered by its relatively low percentage in the blend. This is advantageous to city buildings which are already connected to the grid and would otherwise have to install a new renewable heating system to meet the 2020 renewable energy target of 12%. Indeed, biomethane produced using feedstocks which do offer a gate fee (OFMSW and slaughter waste for example) could be less expensive, possibly resulting in a net income to the AD plant developer, before other revenues are taken into account.

There is an increase in the number of plants producing biomethane for injection into the natural gas grid, with Austria, Germany, Sweden, Switzerland and the Netherlands among the leading markets in this area. The work by the ERI demonstrates that this technology would be largely dependent on financial support, at least until the technology is established and until costs start to fall as knowledge gained impacts on the sector.

ONE OF THE KEY BENEFITS ASSOCIATED WITH BIOMETHANE IS THAT IT CAN BE TRANSPORTED USING CONVENTIONAL NATURAL GAS INFRASTRUCTURE

05.2 BENEFITS OF BIOMETHANE

Thermal energy

Ireland's White Paper on Energy in 2007 set respective targets of 33% renewable electricity and 12% renewable heat by 2020 (although the RES-E target is now 40% since the Carbon Budget in 2008). Support mechanisms introduced by the Irish Government to date have resulted in a steady rise in the deployment of wind energy, from 117MW in 2000 to 1,264MW in February 2010. Using similar incentive mechanisms to help overcome some of the financial barriers associated with biomethane production, Ireland could make a substantial contribution to the RES-H target using this source of renewable energy. Under the baseline scenario of this study, Ireland could produce 15PJ of biomethane per annum, equivalent to around 7% of the White Paper forecast for thermal energy in 2020 (202PJ), or 44% of residential gas consumption (34PJ). Under the technical scenario biomethane could meet 33% of Ireland's overall projected heat demand and 200% of projected domestic gas consumption. Biomethane could therefore play a major role in meeting the 12% RES-H target.

One of the key benefits associated with biomethane is that it can be transported using conventional natural gas infrastructure. Biomethane could be supplied to end customers with no change to existing infrastructure or metering equipment, avoiding the installation of district heating systems or wood pellet/chip boilers and providing renewable heat to buildings connected to the gas grid.

Waste management

While the increase in municipal recycling rates has been significant, Ireland still has a waste management infrastructure that relies heavily on landfill.[18] The EU Landfill Directive stipulates that by 2016, Ireland can only landfill 35% of the level of biodegradable municipal waste produced in 1995.[19] In order to meet the EU Landfill Directive, Ireland needs to deliver waste infrastructure to divert 900,000 tonnes per annum of biodegradable municipal waste from landfill by 2016. Biomethane plants offer local authorities and the private sector a useful alternative to landfill while providing a renewable source of energy in the form of electricity, heat or transport fuel.

Carbon abatement and sustainability

Ireland's target under the Kyoto Protocol is to limit annual greenhouse gas emissions to 13% above 1990 levels over the period 2008 to 2012. Ireland's CO_2 target for the period 2008 to 2012, as set by the Kyoto Protocol, was contravened as far back as 1997. By 2007 annual greenhouse gas emissions were 24.6% above 1990 levels.[20] Furthermore, the EU Burden-sharing Proposals on Energy and Climate Change require Ireland to reduce its greenhouse gas emissions by 20% by 2020, based on 2005 emissions. Using organic waste and other agricultural feedstocks to create biomethane is a sustainable, renewable waste-to-energy solution, which reduces greenhouse gas emissions from landfill and from fossil fuel. In the EU Renewable Energy Directive (2009/28/EC) biofuels produced from residues and lignocellulosic material (such as grass) are awarded 'double credit' when establishing compliance with the 2020 target of 10% renewable energy in transport.[21]

05.

05.2 BENEFITS OF BIOMETHANE continued

Security of supply

Security of energy supply is one of the most important macroeconomic and strategic issues for any country, and even more so for an island nation such as Ireland. Over the last twenty years the energy landscape in Ireland has changed dramatically. In 1990 domestic energy production accounted for 32% of Ireland's energy requirements. However, import dependency has grown significantly due to the decline in natural gas production, coupled with the increase in energy use and, by 2007, only 11% of Ireland's energy consumption was sourced from domestic production. Any disruption to energy imports would consequently have a significant impact on the Irish economy. The production of biomethane from anaerobic digestion could provide Ireland with an indigenous and reliable energy source amounting to 33% of domestic natural gas demand, helping to reduce the dependency on natural gas imported from the UK and mainland Europe. An indigenous supply of biomethane could also provide some protection from volatile international energy prices.

Economic development and innovation

The Government's Strategy for Science, Technology and Innovation outlines a vision for Ireland in 2013 as a country internationally renowned for excellence in research and innovation. Biomethane offers an opportunity for the development of innovative new technologies, processes and skills, which could be used for further inward investment and export to other renewable energy markets. Uptake could be stimulated through demonstration projects involving public and private sector organisations, with a view to tackling a number of issues including the production of low-carbon energy and the treatment of biological waste at a local level. The development of biomethane infrastructure could also generate significant employment opportunities in terms of plant construction, operation and indirect services, consequently creating an estimated 5,000 indirect jobs.

Assuming a plant size of 50,000 tonnes per annum, which would provide sufficient economies of scale in upgrading biogas to biomethane, Ireland would require 183 rural biomethane facilities to process the quantities of grass and slurry feedstocks as described under the baseline scenario **(Table 1)**. A rural digester of this size would, however, most likely be based on the Centralised Anaerobic Digestion (CAD) system and would therefore require a large collection radius.

BIOMETHANE OFFERS AN OPPORTUNITY FOR THE DEVELOPMENT OF INNOVATIVE NEW TECHNOLOGIES

Similarly, a further eight plants of 50,000 tonnes per annum each could process the quantities of slaughter waste and OFMSW as per the baseline scenario. The total investment cost for the number of plants described here and set out in **Table 2** would be of the order of €1.4 billion. A typical biomethane plant may only require three operational employees (plant manager/lab technician and two loader drivers), presenting limited direct employment opportunities. However the indirect impacts could be greater, particularly if Irish developers, contractors and technology companies were established or expanded to build this new capacity.

Table 2: Digesters proposed for Ireland in 2020

Digester type	Number	Feedstock treated	Total feedstock	Capital investment (M€)
Rural	183	50,000 t/a: 29,000 t/a grass (530 ha) 21,000 t/a slurry	9.15 M t/a: 5.3 M t/a grass (97 k ha) 3.87 M t/a slurry	183 * €7m = €1,281m
Slaughter	4	52,000 t/a	208,000 t/a	4 * €15m = €60m
Municipal	4	54,500 t/a	218,000 t/a	4 * €20m = €80m

Source: Singh A, Smyth BM, Murphy JD, Renewable and Sustainable Energy Reviews, Volume 14, Issue 1, January 2010, Pages 277-288.

06.

SUPPORT STRUCTURES

There are clear benefits to increasing the level of biomethane produced in Ireland in terms of energy security, waste management and carbon abatement.

SOME SUPPORT MECHANISMS ARE ALREADY IN PLACE TO ASSIST THE DEVELOPMENT OF BIOENERGY IN IRELAND

Like other renewable energy technologies, the rate of deployment of biomethane will remain slow unless adequate returns are achievable by investors, commensurate with the risk taken in investing in this technology. Some support mechanisms are already in place to assist the development of bioenergy in Ireland, including:

- Renewable Energy Feed-in Tariff (REFIT) of 12c/kWh for electricity produced by anaerobic digestion.
- The Sustainable Energy Authority of Ireland (SEAI) grant aid for biomass CHP/Anaerobic Digestion (AD) CHP providing a capital grant of up to 30% of the initial capital costs.
- Bioenergy Establishment Scheme which provides grants to farmers interested in growing miscanthus and willow.
- Energy Crops Scheme which offers growers €45/ha for areas sown under energy crops under the Single Payment Scheme.
- Government published Bioenergy Action Plan for Ireland which put in place systems to encourage the use of bioenergy in public buildings.
- Renewable heat deployment programme (ReHEAT) provides grants for wood chip/pellet boilers, solar thermal systems and heat pumps.
- The Greener Homes Scheme (GHS) provides assistance to homeowners to purchase new renewable energy heating systems for existing homes.

These support mechanisms do not provide a direct financial incentive to increase the use of biogas for uses other than CHP production. For this reason, biogas is not currently upgraded to natural gas quality since there is no economic incentive to do so. If there was an equivalent support mechanism in place for the production of grid quality biomethane, aligned with a supporting regulatory framework, this could provide the impetus to start a renewable gas industry in Ireland.

07.

REALISING THE POTENTIAL FROM BIOMETHANE

The economic viability of anaerobic digestion projects is currently driven by a combination of gate fees received and incentives provided by the Government under the REFIT scheme for the electricity produced.

APPROXIMATELY 91% OF AGRICULTURAL LAND IN IRELAND IS UNDER GRASS AND IS USED FOR GRAZING CATTLE AND SHEEP OR PRODUCING SILAGE.

There is currently no equivalent incentive for biomethane used as a source of heat or transport fuel. Such a tariff would be relatively straightforward to introduce, if based at the point of injection into the gas grid. Although some form of accreditation and monitoring would be required, particularly where the gas is only used off-grid (in rural locations, for example). Financial incentives alone will not result in high rates of deployment of anaerobic digestion projects as many of the barriers to be overcome are non-financial issues as described below.

Feedstock supply

A key issue when assessing the viability of an anaerobic digester is the availability and cost of sufficient volumes of feedstock in close proximity to the facility. Challenging waste targets such as the EU Landfill Directive mean that there is a very strong incentive to divert waste to alternative treatment facilities such as biodigesters. Indeed, anaerobic digestion plants will be able to charge a significant gate fee to receive organic waste. However, 'prevention and minimisation' strategies which aim to reduce organic waste at source, and increasing maturity of the waste management market (with more biodigesters being erected), will lead to a decrease in the quantity of OFMSW available for new biodigesters and the associated gate fee. Revenues should take into account reduction in gate fees over the life of the facility.

Other feedstock options such as agricultural waste may not receive a gate fee. Grass, for example, may need to be purchased by the biomethane producer. Approximately 91% of agricultural land in Ireland is under grass and is used for grazing cattle and sheep or producing silage. The grass grown on this land may be used as a component feedstock in an anaerobic digestion plant to produce biomethane. If 5% of the land used for silage production was used to produce biomethane, the energy potential from grass feedstock alone could exceed the energy equivalent of 262 million m^3 of natural gas[22] (or enough to supply 200,000 homes).

Animal manures, slurries and slaughter wastes are posing an increasingly difficult problem for waste management. Currently slurries, manures and some slaughter wastes are applied to land. Regulations governing the spreading of these wastes on agricultural land (particularly the Nitrates Directive and the Animal By-Products Regulation) limit the area of land available for environmentally sound disposal. A solution may be to divert these feedstocks to an anaerobic digestion plant first, in order to sanitise the waste.

Digestate removal

Anaerobic digestion generates a by-product known as digestate. Digestate may be used as a fertiliser, compost or topsoil, replacing fossil fertiliser and thereby greatly increasing the sustainability of the agricultural process. However, the Department of Agriculture, Fisheries and Food has implemented strict rules governing the spreading of animal by-products on food-producing land. Anaerobic digesters using slaughter waste may be classified as high or medium risk under the Animal By-Products Regulation and may require alternative means to dispose of the digestate (as opposed to pasture land application).

07.

Supply chain

There are a number of supply chain models for biomethane plants. Large-scale centralised anaerobic digestion facilities require new relationships to be formed between parties from different sectors, for example farmers, waste managers and energy commodity intermediaries. Such interactions can be complex, particularly for larger anaerobic digestion facilities, where farmers must agree to deliver manure and grass feedstocks and collect the digestate; and waste managers must supply biodegradable waste and be willing to pay a reasonable gate fee. Coordinating these supply contracts and guaranteeing sufficient quantity and quality of feedstock can be an issue for large centralised anaerobic digestion facilities. This model can provide the dual benefits of creating security of feedstock supply for the biomethane plant and guaranteeing income or even job security for the local farmers.

Alternatively, farmers could use a cooperative structure to own and operate the biomethane plant. In such a structure, farmers would work together to finance, build and run the facility thereby reducing the number of intermediaries and promoting the facility within a community (which can reduce planning risk by limiting the level of public opposition to the plant). This model has been successfully adopted by farming co-ops in Denmark and Germany.

Finally, a municipal model could involve a large facility to treat municipal waste (source segregated) and to produce biomethane within the city environs which may be used for on-site CHP, transport fuel (as in Stockholm) or injected into the grid for use as a natural gas substitute.

Market awareness and the planning process

Interest in renewable energy has grown significantly in recent years. However, public interest and knowledge around anaerobic digestion is low. This lack of understanding leads to public concern for health, safety and environmental issues when planning applications are made for anaerobic digestion plants; particularly for those that process biodegradable waste. The Sustainable Energy Authority of Ireland (SEAI) identified market awareness as a barrier in 2004 and, despite efforts by a number of private and public sector bodies, the level of understanding among the general public of bioenergy from waste remains low.

Opportunities for biomethane injection into the grid

Gaslink is the independent operator of the natural gas transportation system in the Republic of Ireland. The Code of Operations details the rights and obligations of each party involved in the transportation of gas through the gas grid. The code places obligations on suppliers to book specific capacity, make entry nominations and comply with pressure regulations. Changes to the Code of Operations would need to be made to facilitate the widespread deployment of small biomethane entry points to the grid.

Many countries have standards governing the quality of biomethane that may be injected into the grid; in Austria, for example, the standard is ÖVGW G31. The standard specifies the biomethane in terms of essential components such as minimum methane content and energy value, maximum hydrogen sulphide content and a 'Wobbe index'. The values in the standards are very achievable using upgrading technology. In Ireland, the natural gas specification is outlined in the Code of Operations.

FARMERS COULD USE A COOPERATIVE STRUCTURE TO OWN AND OPERATE THE BIOMETHANE PLANT

The two particular issues that require consideration with respect to the current specification are the oxygen content and the assessment of the implications of unspecified chemical constituents associated with biomethane produced from particular waste streams.

Biomethane as a transport fuel

Considerable investment has been made in the natural gas grid in recent years, resulting in an expansion of the pipeline to include the Midlands, Galway and Mayo regions. While the gas network is relatively extensive, there is a large proportion of the country, mainly in the North West, without access to the network. Biomethane produced in these off-grid areas could, however, be used as a transport fuel. The EU Biofuels Directive and the Government White Paper set a target of 4% biofuel market share (by volume) in the transportation sector by 2010 and 10% by 2020. Biomethane could be an economically viable transport fuel **(Table 3)** and is already used in other countries. Again, the potential for blended gaseous transport fuel (90% natural gas and 10% biomethane) would allow for a cheap transport fuel and compliance with RES-T. It should be noted that the EU Renewable Energy Directive allows a double credit for biofuel from residues and from lignocellulosic materials (such as grass) when assessing compliance with the 2020 target of 10% renewable energy in transport.

Around 25% of biogas produced in Sweden in 2008 was used as a vehicle fuel. Public awareness of the advantages of biogas is increasing in Sweden such that the demand for biogas as a vehicle fuel is greater than the supply in some regions, such as the Stockholm area. Bus services in Stockholm, Upsala and Linkoping all utilise biomethane as a transport fuel and the number of biogas filling stations in the country as a whole amounts to more than 120.[23]

Table 3: Comparison of vehicle fuel costs

Fuel	Unit cost (€/litre)	Energy value (MJ/litre)	Cost per unit energy (€/MJ)
Petrol	1.172	30	0.039
Diesel	1.054	37	0.028
Biomethane (from grass silage)	1.25	37	0.034
CNG – Austria	0.89	37	0.024
CNG – UK	0.71	37	0.019
CNG – Germany	0.70	37	0.019
BioCNG (90% CNG UK, 10% grass biomethane)	0.755	37	0.020

Source: Adapted from Murphy J, 2008, Bio-CNG Transport Fuel of the Future, Bioenergy News 2008, the Sustainable Energy Authority of Ireland.

Note: CNG = Compressed Natural Gas.

08.

CONCLUSION AND RECOMMENDATIONS

This study has found that biomethane represents a significant and under-utilised source of renewable energy in Ireland. The following recommendations might assist in the delivery of biomethane as a future energy resource.

IRELAND HAS AT ITS DISPOSAL THE MEANS TO PRODUCE GREEN ENERGY WHILE SATISFYING EU REGULATIONS RELATING TO WASTE MANAGEMENT AND MEETING RENEWABLE ENERGY SUPPLY TARGETS

Recommendation 1:

Set targets for gas demand to be met with biomethane

For example, the National Biomass Action Plan for Germany set targets for biomethane supply as a percentage of gas demand of 6% by 2020 and 10% by 2030.[24]

Recommendation 2:

Review REFIT tariffs provided for anaerobic digestion

The Government should review the REFIT scheme to provide a tariff for biomethane fed directly into the gas grid. The feed-in tariff should recognise that biomethane produced from organic wastes such as OFMSW, where a gate fee exists, is currently economically viable. However, biomethane produced using agricultural waste or silage may require a higher tariff, to encourage uptake by the farming community.

The German system, as described by the Renewable Energy Source Act and the Renewable Energies Heat Act 16, offers tariffs for biogas based on a number of criteria, some of which are included below in a simplified form:

- 7c/kWh if energy crops, such as grass, are used as a feedstock for biogas production.
- 2c/kWh for biogas upgrading to biomethane.
- 11.67c/kWh for CHP production using biomethane sourced from the gas network.

The International Energy Agency (IEA) has stated that the high investor security provided by the German feed-in-tariff has been a success, resulting in a rapid deployment of renewables, the entrance of many new actors to the market and a subsequent reduction in costs.[25]

Recommendation 3:

Implement new energy regulations to encourage biomethane injection into the grid

Changes to the Code of Operations need to occur to encourage the injection of biomethane into the gas grid. Changes relating to compression, gas analysis, nominations and balancing should be kept simple to allow small producers to come online with minimal bureaucracy. Suitable standards need to be set to regulate the quality of biomethane that can be injected into the gas grid, specifying the chemical properties and energy content of the gas stream. Policy should also be implemented to encourage the use of the biomethane injected into the grid. Companies and building owners also need to be incentivised to purchase biomethane in off-grid areas. The EU Directive 2009/73/EC requires Member States to take concrete measures to assist the wider use of biogas and gas from biomass, such as providing non-discriminatory access to the gas system, taking into account the necessary quality and safety requirements.[26] This latest policy development may provide sufficient impetus to make the necessary changes to the Code of Operations.

08.

Recommendation 4:

Align renewable energy and waste management policy

Ireland landfilled 1.4 million tonnes of biodegradable waste in 2007; an increase of 4% on the previous year.[27] Ireland appears to be moving further away from the first Landfill Directive target of less than one million tonnes of biodegradable municipal waste to be landfilled by 2010 and just over 450,000 tonnes by 2016. In fact, 91.4% of organic waste produced in 2007 was landfilled. Forfás has stated that Ireland's comparatively poor performance can be traced back to a failure to deliver key waste management infrastructure by local authorities. Clearly, additional capacity will be needed for the OFMSW if Ireland is to meet the target set under the EU Landfill Directive.[28]

Ireland's target under the EU Renewable Energy Directive for 2020 is for renewable sources to account for 16% of total final energy use. This will be achieved through 40% of electricity generation, 12% of our heating demand and 10% of our transport fuels coming from renewable sources. The contribution from renewables was 3.7% and 1.2% for heat and transport energy respectively in 2008.[29] Biomethane produced from municipal solid waste could contribute significantly to Ireland's renewable heat or transport targets while at the same time diverting organic waste away from landfills.

High levels of uncertainty about the direction of Irish waste management policy have discouraged investment in waste infrastructure. A clear and definitive policy should be implemented encouraging the diversion of 870,000 tonnes per annum of organic waste to anaerobic digestion facilities. A policy such as this, that guarantees feedstock supply and has the added economic benefit of a gate fee, in addition to the tariffs provided by REFIT, would encourage investment in the production of biomethane. Such a policy could generate up to 60 million m^3 of natural gas quality fuel (assuming all OFMSW is utilised), which could be used as a source of thermal or transport energy, in addition to ensuring that Ireland meets its Landfill Directive target.

Recommendation 5:

Implement new support structures for agriculture

Family Farm Incomes have dropped significantly in the past few years. The biomethane industry can supplement the income of farmers while ensuring the production of sustainable biofuel and the maintenance of an aesthetic countryside. A grant scheme should be initiated to provide an incentive to farmers to produce feedstock for biomethane production.

Recommendation 6:

Additional research and development funding for renewable gas technologies

More funding should be directed at research, development and demonstration of renewable gas technologies to build upon core expertise in biotechnology and information technology.

Ireland has at its disposal the means to produce green energy while satisfying EU regulations relating to waste management, meeting renewable energy supply targets in heating and transport, improving security of supply, creating jobs, all the while maintaining a grass-based agricultural system. Ireland has an extensive gas grid connected to over 640,000 homes and businesses, which can provide for the delivery of renewable gas and in so doing make a major contribution towards meeting our renewable energy targets by 2020. There are challenges that need to be overcome to capture this opportunity but these are not insurmountable. Action now in addressing these issues will establish a market for a renewable gas industry in Ireland which will benefit all our fellow citizens for years to come.

A.

APPENDIX A - REFERENCES

1. Eurostat European Commission, Panorama of energy: Energy statistics to support EU policy and solutions (Luxembourg: Office for Official Publications of the European Communities, 2009).
2. Howley M, Ó Gallachóir B and Dennehy E, Energy in Ireland 1990-2008 (Cork: Energy Policy Statistical Support Unit, the Sustainable Energy Authority of Ireland, 2009).
3. Gaslink – Gas System Operator, Transmission Development Statement 2008/09 to 2014/15 (Cork: Gaslink, 2009).
4. Howley M, Ó Gallachóir B, Dennehy E and O'Leary F, Renewable Energy in Ireland 2008 Report (Cork: Energy Policy Statistical Support Unit, the Sustainable Energy Authority of Ireland, 2008).
5. Government White Paper March 2007, 'Delivering a Sustainable Energy Future for Ireland'.
6. See 2.
7. SEAI Provisional Energy Balance 2009, published March 31 2010.
8. Fitzgerald J, Bergin A, Conefrey T, Diffney S, Duffy D, Kearney I, Lyons S, Malaguzzi Valeri L, Mayor K, and Tol R, Medium Term Review 2008 – 2015 (Dublin: Economic and Social Research Institute (ESRI), 2008).
9. See 2.
10. See 2.
11. Curtis J, Anaerobic Digestion: Benefits for Waste Management, Agriculture, Energy, and the Environment (Johnstown Castle, Wexford: Environmental Protection Agency (EPA), 2005).
12. Murphy JD, McKeogh E and Kiely G, 'Technical/economic/environmental analysis of biogas utilisation', Applied Energy, 77(4) (2004), 407-27.
13. See 12.
14. Singh A, Smyth BM and Murphy JD, 'A biofuel strategy for Ireland with an emphasis on production of biomethane and minimisation of land take', Renewable and Sustainable Energy Reviews, 14(1) (2010), 277-88.
15. See 14.
16. See 14.
17. See 14.
18. Forfás, Waste Management Benchmarking Analysis and Policy Priorities (Dublin: Forfás, 2008).
19. EC, Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (Luxembourg: Official Journal of the European Communities, 1999).
20. See 2.
21. EC, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Strasbourg: Official Journal of the European Union, 2009).
22. Curtis J, Bioenergy – opportunities for agriculture, industry and waste management (Johnstown Castle, Wexford: Environmental Protection Agency (EPA), 2006).
23. AEBIOM, A Biogas Road Map for Europe (Brussels: AEBIOM European Biomass Association, 2009).
24. BMU and BMELV, National Biomass Action Plan for Germany (Berlin: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) and Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV), 2009), available on http://www.erneuerbare-energien.de/inhalt/44591/3860/.
25. IEA, OECD. Energy Policies of IEA Countries Germany 2007 Review. Paris: International Energy Agency and Organisation for Economic Co-operation and Development; 2007.
26. EC, Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC (Brussels: Official Journal of the European Union, 2009).
27. Le Bolloch O, Cope J, Kurz I, Meaney B and Higgins T, National Waste Report 2007 (Johnstown Castle, Wexford: Environmental Protection Agency (EPA), 2009).
28. See 19.
29. See 4.

B.

APPENDIX B - ABBREVIATIONS

The following abbreviations are used in this report:

AD	Anaerobic digestion
CAD	Centralised anaerobic digester
CCGT	Combined cycle gas turbine
CER	Commission for Energy Regulation
CH_4	Methane
CHP	Combined heat and power
c/kWh	Euro cents per kilowatt hour
CNG	Compressed natural gas
CO_2	Carbon dioxide
EfW	Energy from waste
ERI	Environmental Research Institute
ESRI	Economic and Social Research Institute
EU	European Union
GHG	Greenhouse gas
GHS	Greener homes scheme
H_2S	Hydrogen sulphide
kt	Kilotonnes
ktoe	Kilotonnes oil equivalent
ktpa	Kilotonnes per annum
kWh	kilowatt hour
M€	Million euros
m^3	Cubic metres
MJ	Megajoules (1 x 10^6 joules)
Mm^3	Million cubic metres
Mt	Million tonnes
Mtpa	Million tonnes per annum
MW	Megawatt (1 x 10^6 watts)
OFMSW	Organic fraction of municipal solid waste
PJ	Petajoule (1 x 10^{15} joules)
REFIT	Renewable energy feed-in tariff
ReHEAT	Renewable heat deployment programme
RES-E	Electrical energy from renewable sources
RES-H	Thermal energy from renewable sources
RES-T	Transport energy from renewable sources
ROI	Republic of Ireland
SEAI	Sustainable Energy Authority of Ireland
t	Tonnes
t/a	Tonnes per annum
UCC	University College Cork

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T: +353 21 453 4000
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