Renewable Gas Forum
Irish Green Gas Ltd

Position Paper 2019

Delivering a Sustainable Solution for Agriculture & Energy

Executive Summary

Ireland is currently facing many challenges, none more than meeting the EU 2030 targets for decarbonisation and renewable energy production, now that the 2020 targets have been missed. There is no time to lose in our endeavours to meet 2030 targets and achieve the levels of sustainability and competitiveness required for Ireland Inc. to maintain its attractiveness for Foreign Direct Investments and assist our indigenous industries to remain competitive in global markets.

Renewable Gas offers a significant opportunity for rural Ireland. With the support of local communities and the agri sector, Ireland can play its part in addressing Climate Change, putting the environment front and centre through sustainable best practices and efficient management of natural resources. Future employment throughout rural Ireland can be secured by producing renewable gas from feedstocks such as slurries, excess grass and rotation crops.

The European Commission has shown Ireland as having the largest potential to produce Biomethane in Europe, estimating 20% of current natural gas demand substitution is achievable by 2030.

The pillar industries in Ireland of agri food, biopharma, beverages and biomedical have mandatory targets to become carbon neutral by 2030. These industries have identified the absolute necessity to be sustainable and competitive in the global markets, maintaining the interest of the global consumer to purchase Irish produce. Achieving these targets is heavily reliant on the establishment of a Renewable Gas industry in Ireland.

The full supply chain of the Renewable Gas industry in Ireland is ready and willing to deliver on 20% Renewable Gas penetration by 2030.The industry is forward planning towards achieving and delivering the 2050 targets. The economic, environmental and health benefits of supporting a Renewable Gas industry has been proven to provide a net positive benefits for Irish society as a whole.

The only remaining hurdle to achieving this opportunity is the provision of suitable market arrangements to support the Renewable Gas industry. The provision of clear policy and economic signals to producers from policy makers is required to ensure the cost of production can be recovered over the lifetime of a project. To this end, the Irish government have committed to supporting the Renewable Gas industry in Ireland, with cross departmental support of the benefits Renewable Gas can offer to Ireland Inc.

A specific Biomethane Support Scheme, as recommended by Element Energy, (independent consultants commissioned by Government to assess the potential of Biogas and Biomethane) is the most effective way to mobilise this potential and has been proven in other jurisdictions already. Clarity on this support scheme is needed by the industry and the RGFI calls upon the Irish government to provide this.

Renewable Gas offers the lowest cost (1/3rd the cost of the alternatives) and least disruptive solution for Renewable Heat, delivering 90% efficiencies through autonomous use on site with CHP and condensing boilers.

At this point the Renewable Gas industry of Ireland needs leadership from Government to support the industry, from across multiple departments, in the interest of Ireland Inc. Communities and Industries in Ireland are ready to play their part in the step change required to make Ireland a sustainable, competitive and global leader in renewable energy.

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About Renewable Gas Forum of Ireland

The Renewable Gas Forum of Ireland (RGFI) is a not-for-profit industry forum which represents the interests of all parties in the renewable gas industry across the island of Ireland, North and South. RGFI has taken responsibility for the promotion and dissemination of knowledge of the benefits that renewable gas presents for Ireland. RGFI is working with its members and policy makers to identify opportunities and deliver real solutions to meeting Ireland's decarbonisation and climate challenges for the benefit of society as a whole.

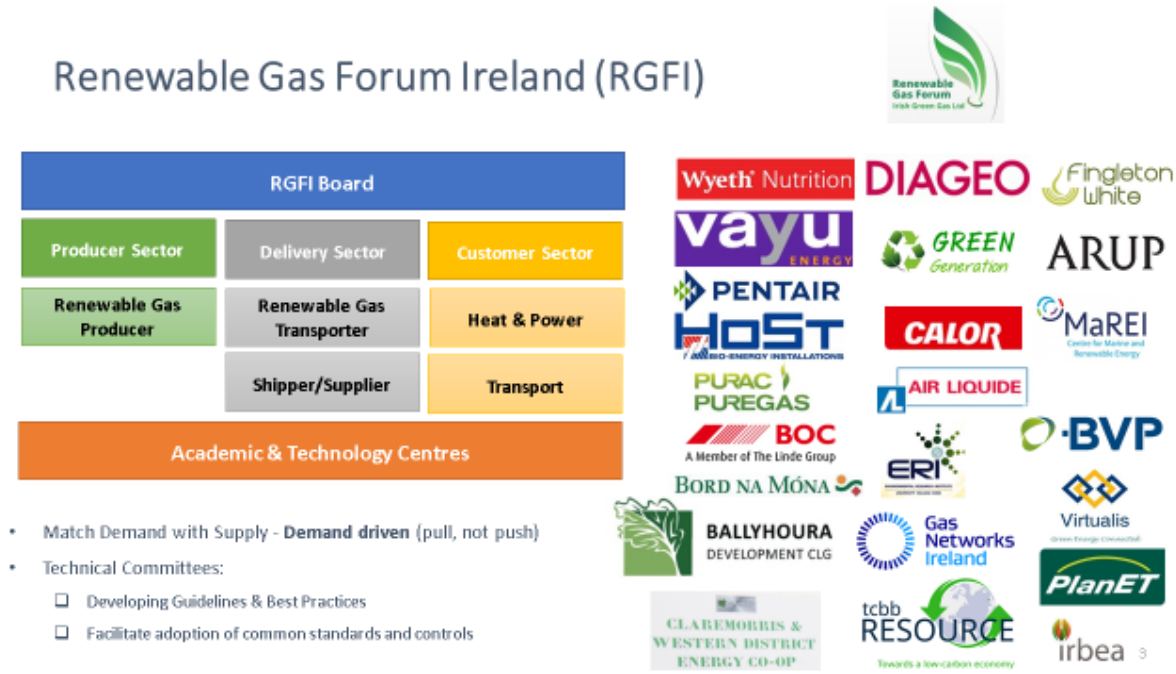


Figure 1: Infographic of the Renewable Gas Forum of Ireland

The Climate Challenge

Global and EU Climate Action

In December 2015, Ireland was one of 188 nations to sign up to the 'Paris Agreement' which aims to restrict global temperature rise to less than 2°C above pre industrial levels. The European Union (EU) has chosen to be a global leader on climate action setting out a vision of 80 – 95% reduction in emissions by 2050, relative to 1990 levels. Additionally, the EU has set out in its Climate and Energy Package binding targets for 2020 which each member state must meet. For Ireland this requires;

- **20%** reduction in Green House Gas (GHG) emissions, relative to 2005
- **16%** energy from Renewable Energy Sources (RES)
    - 40% RES-E, 12% RES-H, 10% RES-T

Additionally, targets for 2030 have now been agreed which each member state must achieve;

- **40%** reduction in Green House Gas (GHG) emissions, relative to 2005
- **32%** energy from Renewable Energy Sources (RES)

Irelands Climate Action Status Overview

Emissions Progress

Despite efforts to reduce GHG emissions, the Environmental Protection Agency (EPA) projections suggest that even with additional measures, Ireland looks to set to fail on their emissions targets for both 2020 and 2030.

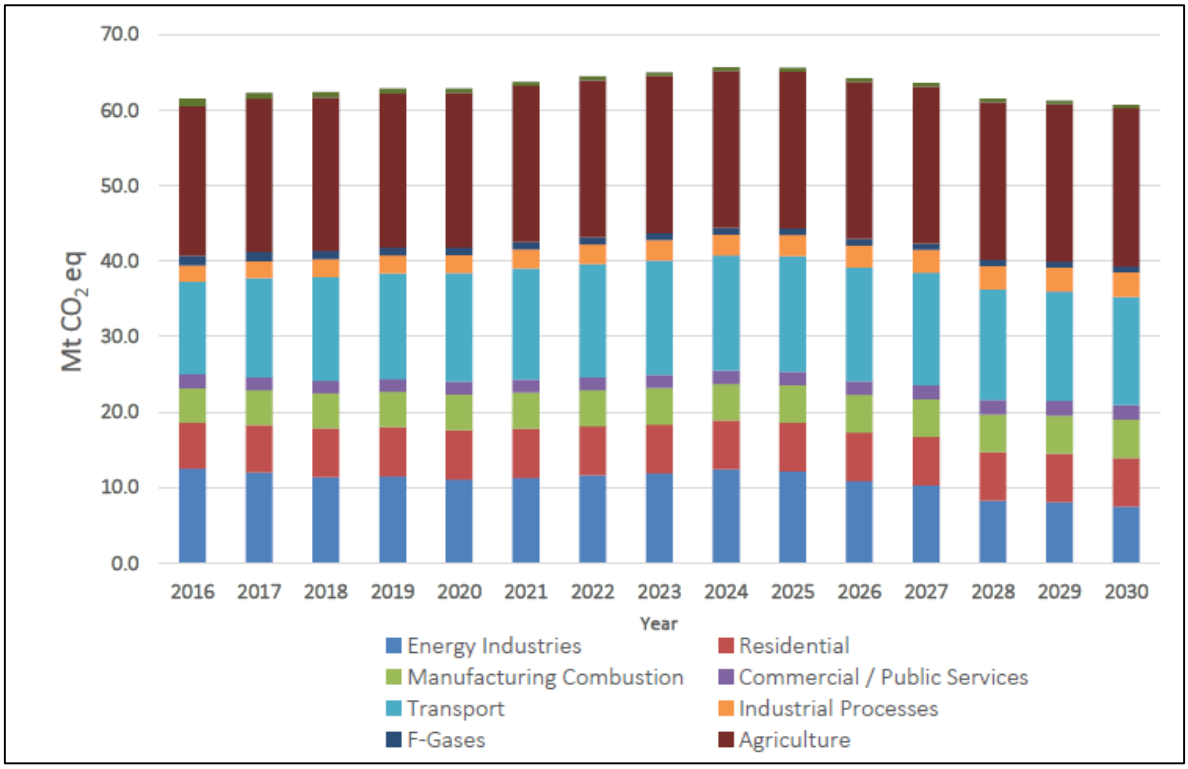


Figure 2: EPA Projections of Irelands Emissions 2017
(http://www.epa.ie/pubs/reports/air/airemissions/ghgprojections2017-2035/2018_Seminar_GHG_Projections_to_2035.pdf)

Ireland's emissions can be categorised into what are referred to as "ETS" and "non –ETS" sectors. The ETS sector covers parties who partake in the EU Emissions Trading Scheme and are made up of large energy users across the Power Gen, manufacturing and industrial sectors. The obligation to meet these emissions targets lies with the parties partaking in the scheme. The Irish government are responsible directly for emissions associated with the non - ETS sectors of which agriculture accounts for almost half.

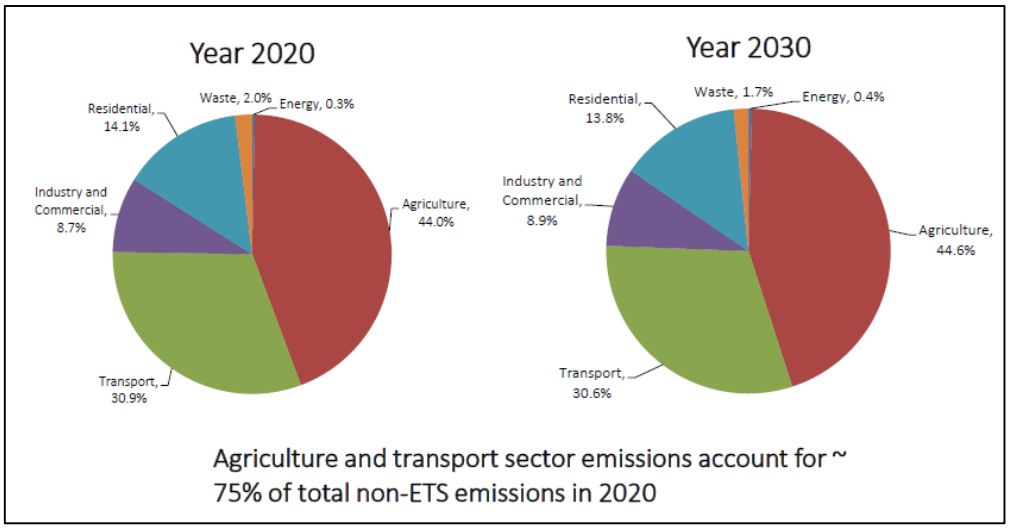


Figure 3: Irelands Non-ETS Emissions Projections (EPA)
(http://www.epa.ie/pubs/reports/air/airemissions/ghgprojections2017-2035/2018_Seminar_GHG_Projections_to_2035.pdf)

Renewable Energy Progress

By the end of 2015, renewable energy as a share of final energy consumption amounted to 9.1%. This was broken down as follows:

- **Renewable Electricity (RES-E):** 25.3% of the 40% target had been met at the end of 2015;
- **Renewable Heat (RES-H):** 6.5% of the 12% target was met by the end of 2015;

- **Renewable Transport (RES-T):** 5.7% of the 10% target had been met at the end of 2015.

Ireland is projected to fall short on its 2020 targets, in particular in the RES-H and RES-T sectors with latest projections estimating a total RES penetration of 11.9% by 2020[1]. Differing media reports estimate the cost of fines associated with failure to meet EU renewable and emissions targets for 2020 could be up to €600 million[2].

Renewable Gas

About Renewable Gas

Renewable Gas is most commonly produced today from the Anaerobic Digestion (AD) and upgrading of biological wastes and residues, such as household organic wastes, sludges, slurries and silage. Organic feedstock is loaded into large digester tanks and placed in an oxygen starved environment, similar to what would be found in a cow's stomach. This results in the organic material naturally breaking down in a fermentation process overtime and the end result is the production of biogas, which is approximately 60% pure methane. The biogas can then be put through an upgrading process where primarily carbon dioxide is removed resulting in a product which is >97% methane and suitable for injection into the natural gas grid. Anaerobic Digestion is a well-established technology worldwide with 17,662 plants existing in Europe as of 2016, with 497 of these now upgrading to biomethane for gas grid injection[3].

Aside from AD, Renewable Gas can also be produced through other processes such as gasification and Power-to-Gas, using renewable electricity to convert water into hydrogen and oxygen. These technologies are less mature than AD at present but offer substantial opportunities for the expansion of Renewable Gas production in the future.

Benefits of Renewable Gas

Renewable Gas is a clean, renewable, carbon neutral fuel which can play a major role in decarbonising Ireland's economy and avoiding potential fines. In addition, Renewable Gas also has benefits for the agri and waste sectors and provides a stimulus for rural Ireland.

Agriculture

GHG emissions in agriculture account for 33% of national emissions[4] and originate from animal sources (cattle and sheep rumination and associated manure) and crop fertilisers (nitrogen). Agriculture emissions are expected to increase further due to a projected increase in dairy cow numbers and proposals to increase food production and exports, as set out in Food Harvest 2020. Ireland needs to sustainably address GHG emissions from agriculture, and Renewable Gas offers a solution to do so. Renewable Gas can reduce emissions from agriculture in a number of ways.

1. The use of manure as a feedstock in the AD process avoids methane emissions which would have gone to atmosphere previously.
2. The use of the digestate substrate from the AD process can act as a natural and high quality replacement for chemical fertiliser. Spreading the digestate on land eliminates the emissions associated with the chemical fertiliser production process.
3. The use of short rotation catch crops on tillage land and high quality bio-fertiliser digestate to sequester carbon in soil, turning the farm into a carbon sink.
4. Food and beverage production processes also contribute a further 13% to national emissions and these industries are largely dependent on Natural Gas as their primary energy source.

Waste

The Landfill Directive (Directive 1999/31/EC) provides for the diversion of biodegradable waste from landfill and sets out targets for same. The quantity of biodegradable material sent to landfill has decreased

[1] http://www.epa.ie/pubs/reports/air/airemissions/ghgprojections2017-2035/2018_Seminar_GHG_Projections_to_2035.pdf

[2] https://www.independent.ie/irish-news/ireland-faces-annual-eu-energy-fines-of-600m-36857141.html

[3] http://european-biogas.eu/wp-content/uploads/2018/01/2018.01.09.GIE_BIO_2018_A0_1189x841_FULL_415_clean_final.pdf

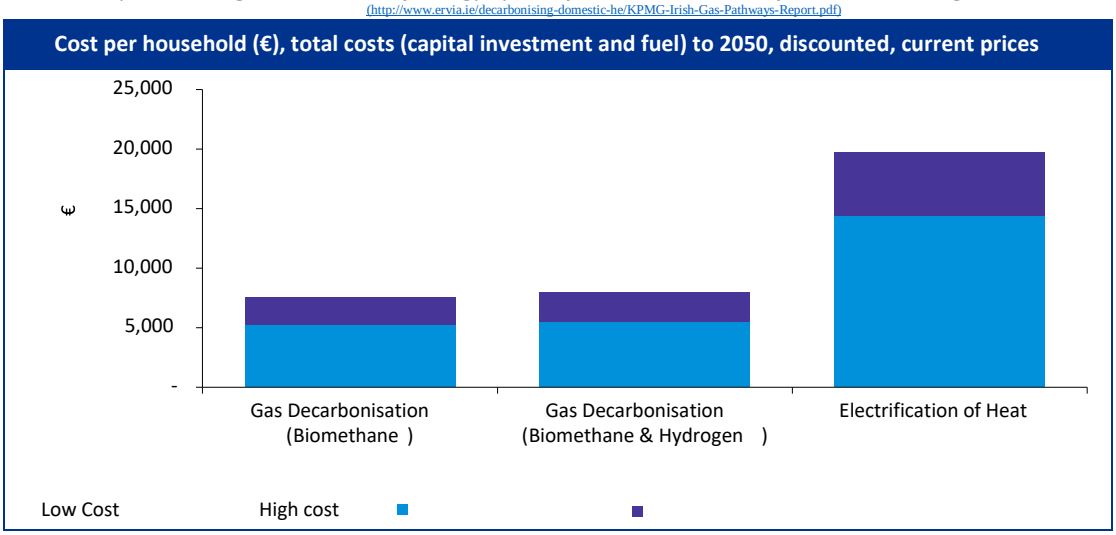
[4] http://www.epa.ie/pubs/reports/air/airemissions/EPA%202015%20GHG%20Projections%20Publication%20Final.pdf

since 2010 when source separation of waste was introduced. However, it is estimated that approximately 35% of solid waste disposed in landfill is still municipal organic waste, representing approximately 400,000 tonnes per annum. The "brown bin" organic waste collection for households, which was implemented in 2016, now represents a significant opportunity to produce Renewable Gas, assisting in the decarbonisation of energy while also reducing the need for landfill and incineration.

Heat

Efforts to address heat decarbonisation to date have been minimal and have focused mainly on wood biomass. Electrification of residential and commercial heat with heat pumps and higher efficiency rating building regulations represent a significant portion of the current government policy for decarbonisation of heat going forward. However, this requires intrusive and expensive "deep" retrofits of people's homes. In June 2018, KPMG published a study on behalf of Ervia, titled 'Decarbonising Domestic Heating in Ireland'[5]. The study demonstrates how the displacement of natural gas supply with carbon-neutral Renewable Gas can deliver complete decarbonisation of domestic heating for 1 million households at less than 1/3 of the cost of complete deep retrofit and heat pump technologies alone. Additionally, this could be achieved without the need for significant customer disruption (caused by deep retrofitting of households) and without the need for expansion of the electricity grid.

Table 1: Graphic showing Levelised Cost of Energy options for Decarbonisation of Domestic Heating in Ireland
(http://www.ervia.ie/decarbonising-domestic-he/KPMG-Irish-Gas-Pathways-Report.pdf)



Transport

Efforts to address transport demand with renewable alternatives has so far focused on increased use of liquid biofuels (supported by the Biofuels Obligation Scheme) and higher penetration of electric vehicles, as set out in the Government's Smarter Travel plan. The two main biofuels in use in Ireland are biodiesel and bio-ethanol. However, it is becoming clear that biofuels are an extremely expensive solution, with questionable emissions benefits[6]. Almost 85% of biofuels were imported in 2014[7]. The EU Commission has raised concerns over the traceability of many of these fuels.

The development of the Electric Vehicle (EV) market was also targeted and incentivised[8] to reduce emissions in our urban centres. To date the adoption rates have been lower than expected, with c. 5,000 EVs registered in Ireland to the end of 2018. Current EV technology is not suited to Heavy Goods Vehicles (HGVs) and buses which account for a third of transport emissions. Compressed Natural Gas (CNG) is a proven, mature technology suited to HGVs and busses. CNG infrastructure and vehicles, which are currently being rolled out in Ireland, are fully

[5] http://www.ervia.ie/decarbonising-domestic-he/KPMG-Irish-Gas-Pathways-Report.pdf
[6] https://www.iisd.org/gsi/biofuel-subsidies/biofuels-what-cost
[7] 141,623,389 litres of 166,920,016 litres – NORA Consolidated 2014 Sustainability Data
[8] To encourage their uptake electric vehicles receive VRT relief in addition to the direct grant support available through the Sustainable Energy Authority of Ireland (SEAI) and low annual motor tax rate.

compatible with Renewable Gas and can offer customers a carbon-neutral alternative to diesel.

Electricity

Significant progress has been made in decarbonising electricity in Ireland through the development of wind energy, however, wind is an intermittent source of energy and requires back up from dispatchable synchronous generation such as gas to ensure the security of the power system. As a result, over 50% of electricity is still produced from natural gas today. Substitution of this with Renewable Gas offers a simple solution to further decarbonise the electricity sector which requires no further infrastructural changes to the power system or power plants and is complimentary of high penetrations of wind energy.

Table 2: Summary of Benefits of Renewable Gas

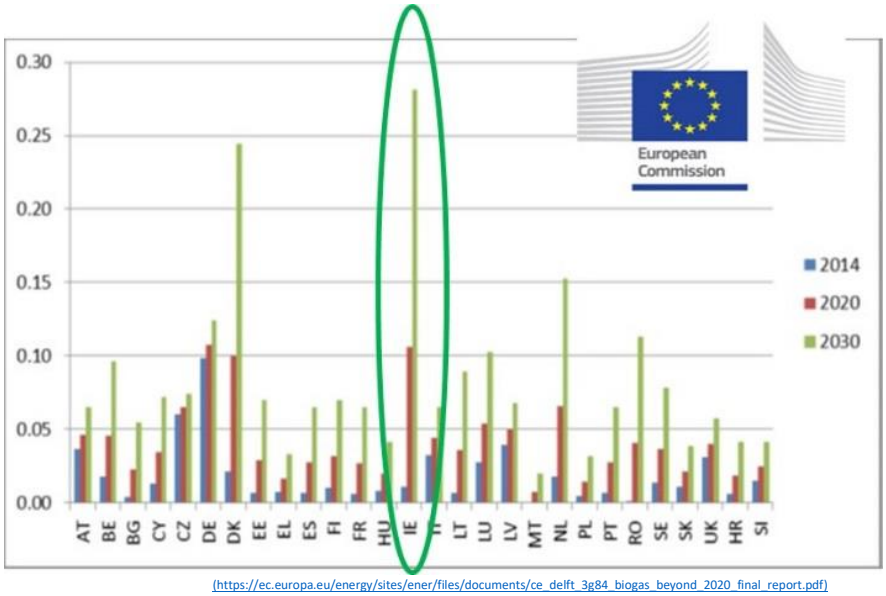
Benefit	Description of Benefits
FDI retained / won	• Value of existing FDI retained / new FDI won due to availability of Renewable Gas. This will lead to increased revenue to the exchequer through taxation.
Employment	• Positive impact on national earnings and Exchequer returns • Potential for 2,500 direct and 4,000 indirect jobs within 10 years where Renewable Gas used as a fuel for transport • Value to Irish State: €160m (projected tax received and social welfare avoided)
Security of supply	• Potential for Renewable Gas to satisfy over 20% of Ireland's gas demand by 2030, reducing reliance on imported fuels
No modification to existing infrastructure	• Existing gas network and end-user energy infrastructure (existing boilers and Combined Heat and Power (CHP) facilities owned by commercial, industrial and domestic customers) require no modification to accept Renewable Gas – only technical requirement is to inject Renewable Gas into the system
Existing route to market	• Distribution through the gas network (currently connected to circa 700,000 customers) provides existing route to market to customers with demand for a decarbonised primary energy fuel
Rural development	• Nature of Renewable Gas production is that it takes place in geographically dispersed and typically rural locations • Production facilities and local services to support production will present significant benefits in the form of rural employment, local investment and infrastructure development and increased rural income levels
Sustainability	• Renewable Gas can be produced from sustainable organic waste resources, a key advantage over biofuels produced from energy crops. • By displacing non-renewable fuel sources, Renewable Gas will also reduce pollution and improve land, air and water quality, resulting in health benefits for the wider population
Flexibility as a fuel source	• Renewable Gas is equally applicable to any of the primary energy sources (heat, electricity or transport) as well as for use in industrial and manufacturing processes which currently rely on Natural Gas. • It is possible to target its usage towards sectors which pose the most significant difficulties to decarbonisation of Ireland's economy.

A Renewable Gas Target for Ireland

An EU Commission report has shown Ireland as having the largest potential per capita for Renewable Gas production in Europe, estimating a realisable potential of 13 TWh by 2030[9]. The Sustainable Energy Authority of Ireland (SEAI) has also undertaken research on this topic finding that up to 28% could be financially feasible when considering access to resources in close proximity to the gas grid[10].

[9] https://ec.europa.eu/energy/sites/ener/files/documents/ce_delft_3g84_biogas_beyond_2020_final_report.pdf

[10] https://www.seai.ie/resources/publications/Assessment-of-Cost-and-Benefits-of-Biogas-and-Biomethane-in-Ireland.pdf



(https://ec.europa.eu/energy/sites/ener/files/documents/ce_delft_3g84_biogas_beyond_2020_final_report.pdf)

Across Europe, countries are now realising the benefits of Renewable Gas. The French government for example has set a mandatory target of 10% Renewable Gas by 2030 with negotiations now underway considering increasing this target to 30%. This has resulted in a build out rate of Renewable Gas production plants averaging one every two weeks in recent years[11]. In 2016 alone, 4.9 TWh of Renewable Gas was added to the European gas grid with the likes of the Germany, the United Kingdom, the Netherlands and Sweden all leading the charge. Despite Ireland's massive potential for production of biomethane, we remain one of only a few EU member states yet to achieve biomethane production.

Given this context the Renewable Gas Forum of Ireland (RGFI) are advocating that a mandatory target of **20% Renewable Gas by 2030** be set for Ireland. This would require in the region of 11.6 TWh of Renewable Gas to be produced per annum which is less than the realisable potential set out by the EU Commission and the SEAI.

Figure 5: Schematic of Renewable Gas Projections

Resource Potential and Sustainability Requirements

Resource Potential

Renewable Gas can be produced from many indigenous feedstocks. For example, Ireland could theoretically produce 81% of current gas demand from grass silage and cattle slurry alone[12]. Other sustainable feedstocks such as food industry wastes, poultry litter, pig slurry, catch & rotation crops[13], along with future potential resources such as Power to Gas

[11] http://www.grtgaz.com/fileadmin/plaquettes/fr/2018/Panorama-du-gaz-renouvelable-2017.pdf

[12] https://www.sciencedirect.com/science/article/pii/S0306261916317524

[13] A catch crop is a crop grown in the space between two main crops or at a time when no main crops are being grown.

and micro-algae production mean that Ireland could potentially become a net exporter of Renewable Gas.

Food Industry Wastes

Food Industry Waste represents the highest realisable percentage penetration by 2030 as much of the feedstock is mandated by the Land Fill Directive to find a suitable end of life use, often resulting in the receipt of a gate fee for the disposal of the waste. The "brown bin" organic waste collection for households, which was implemented in 2016, now represents a significant opportunity to produce Renewable Gas. In addition to existing available feedstocks currently being used for alternative uses such as composting or biogas production, food waste represents a realisable potential of about 1.6 TWh by 2030.

Animal Manures and Slurries

Animal manures and slurries represent a significant component of Ireland's GHG emissions from Agriculture. Utilisation of these waste streams in an AD process can result in significant GHG savings for the Agri sector through avoided methane emissions being leaked into the atmosphere. In addition to this, the by-product of the AD process, referred to as digestate, works as a high quality bio-fertiliser which can be spread back on the land to increase carbon sequestration in the soil whilst also reducing emissions associated with the production of chemical fertilisers. The actual biomethane yields achieved from animal manures and slurries are low in comparison to yields from other crop based feedstocks. However, these feedstocks are critical to the overall AD process as they add moisture and bacteria to support the digestion process and can be considered as carbon negative in terms of carbon abatement using a life cycle assessment. It is estimated that by 2030, roughly 2,778 GWh of resource potential could be theoretically available.

Grass Silage

Ireland has a unique opportunity in respect of grass silage due to the fact 92% of Agricultural terrain is currently used for grass production, equal to about 4 million hectares. Teagasc have carried out extensive research into good grassland management practices. Ireland currently, despite excellent environment conditions to do so, only produce on average about 6 tonnes of dry matter (DM) / hectare / annum of grass. Teagasc are currently undertaking an extensive public campaign, "Grass10", to try bring this figure up to 10 t (DM) / hectare / annum[14]. Research has shown that Ireland can produce c.12 million t (DM) of silage in excess of the silage quantity required for existing and future targeted increases in milk and meat production[15]. To put this in context, 2.5 million t (DM) of silage /annum would be sufficient to support 20% of Renewable Gas production in Ireland. In fact AD facilities using the increase in national silage output as a feedstock could act as an animal feed buffer during times of a fodder crisis as experienced in 2018. Allocating the AD feedstock in the aforementioned scenario would feed circa 1,000,000 cattle. If this buffer was used for 15 days it would reduce the production of Renewable Gas by less than 1%. This shortfall could readily be supplied by existing natural gas supply infrastructure in the same way as natural gas is used to generate increased amounts of electricity to support reduced output of electricity from wind turbines in times of low wind speeds.

Catch and Rotation Crops

The use of catch / rotation cropping on tillage land during periods where the land is traditionally left barren has numerous benefits for soil fertility and biodiversity. A summary of these benefits are shown below. These catch crops do not need to be fully ripened to be utilised in the AD process with the majority of energy content captured over the early stages of crop development making the application suitable for short rotation periods of 3-4 months. Although the tillage sector only represents a small amount of Irish agriculture at present, the application of catch cropping on these lands does represent a sizeable opportunity for Renewable Gas production.

[14] https://www.teagasc.ie/crops/grassland/grass10/

[15] How much grassland biomass is available in Ireland in excess of livestock requirements? McEniry *et al*., 2013, Irish Journal of Agricultural and Food Research 52: 67–80, 2013

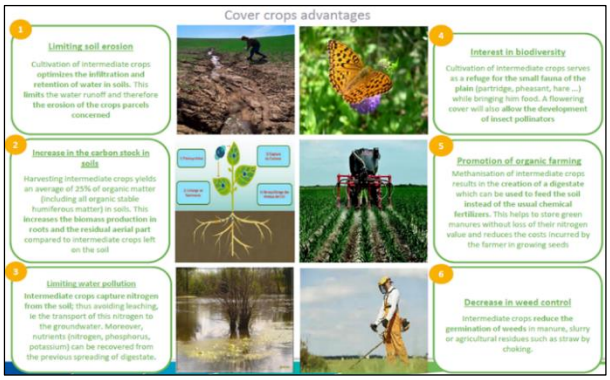


Figure 6: Advantages associated with the use of Catch / Rotation Crops

Power to Gas

Power to Gas (P2G) is unique to other forms of Renewable Gas production in the fact that it does not rely on the application of bio-energy resources to produce Renewable Gas. P2G is produced through a chemical process known as electrolysis which breaks down water into its elemental components, hydrogen (H) and Oxygen (O_2). This hydrogen can then go through a methanation process, combining it with CO_2, to produce Renewable Gas. The process relies on a renewable source of electricity such as Wind or Solar to maintain the chemical reaction. Due to this the quantities of P2G achievable by 2030 is heavily reliant on how it is treated from an electricity market perspective. P2G offers many synergies for the electricity and gas sectors due to the fact:

- It can act as a buffer to the intermittency of wind / solar power which at present is curtailed at times the grid cannot accept it,
- It offers an economic prospect of long term storage which will be required to operate high RES power systems. At present significant advances are taking place in battery storage technology. However, these technology types are primarily aimed to resolve grid issues over the seconds to low hour ranges. Outside of this, Power to Gas is the only economically viable form of renewable energy storage,
- Through the application of a methanation process, the residual CO_2 released from the AD process can be captured and utilised which increases the sustainability of the overall production process.

Table 3: Example of Potential Feedstock Breakdown to Achieve 20% Renewable Gas

Renewable Gas sources	Potential Volumes by 2030	% accessible	Estimated production of Renewable Gas by 2030 (GWh/yr)
Domestic & Commercial Organic Waste	2 Million t ~ 2,000 GWh[16]	92%	1,855
Agricultural manures	2,778 GWh	19%	539
Additional grass (above livestock demand)	28,100 to 54,798 GWh	32% / 16%	8,894
Rotation / Catch Crops	Unknown		339
Total			**11,627**

[16] Source: Bio-waste Market & Feedstock Study by Fehily Timoney & Co. (2017)

Sustainability Criteria

The EU Renewable Energy Directive (RED) sets out the minimum compliance requirements for all renewable energy fuels. Key among these requirements for liquid, gaseous, and solid fuels are the "Lifecycle Sustainability Criteria Thresholds". RED obliges Renewable Gas used in the heat sector to have a carbon intensity of no more than 32 gCO_2/MJ, which is equivalent to a 60% reduction from the EU fossil fuel reference. These targets can be achieved by co-digesting wastes with volumes of grass silage and rotation crops, with further carbon savings possible from compliance with good practice guidelines and efficient agricultural processes.

The RED has been transposed in December 2018 for the period 2021 to 2030 and this version is referred to as REDII. REDII has been through several revisions already with notable changes in the sustainability criteria to a 70% reduction (24 gCO_2/MJ) for Renewable Gas. When REDII is finally concluded, any changes to criteria will not be retrospective (i.e. plants operational before 2021 will not be impacted) but subsequent plants may need to comply with a tighter carbon intensity threshold. The complete Renewable Gas production lifecycle offers up several opportunities to achieve such carbon savings, these can include;

1. CO_2 capture and utilisation to displace Industrial demand and use of CO_2.
2. Amendments to co-digestion feedstock menu.
3. Improvements to digestate (bio-fertiliser) management and land spreading controls.
4. Tighter AD process controls to eliminate methane slippage.
5. Use of onsite renewable energy to meet on site load (solar, biofuels, own biogas use, etc.).
6. Incorporation of Hydrogen from Power to Gas (Green Hydrogen) to convert CO_2 to CH_4 (Methanation).
7. Incorporation of Carbon Capture and Storage (Renewable Gas Energy with CCS – BECCS)

Guarantees of Origin and the Irish Green Gas Certification Scheme

RGFI along with a number of industry partners undertook a project in 2017 to deliver a blueprint for an Irish Green Gas Certification scheme (GGCS). The GGCS acts to validate the sustainability of a producer's Renewable Gas production process, using methodologies defined by best international practice in adherence with the GHG protocol , WRI guidelines for mandatory reporting and the Carbon Disclosure Project (CDP) in Ireland.

The methodology designed assesses the full life cycle of the production process of renewable gas from cultivation through to end-use, supported by an auditing and verification process which ensures a robust reporting mechanism.

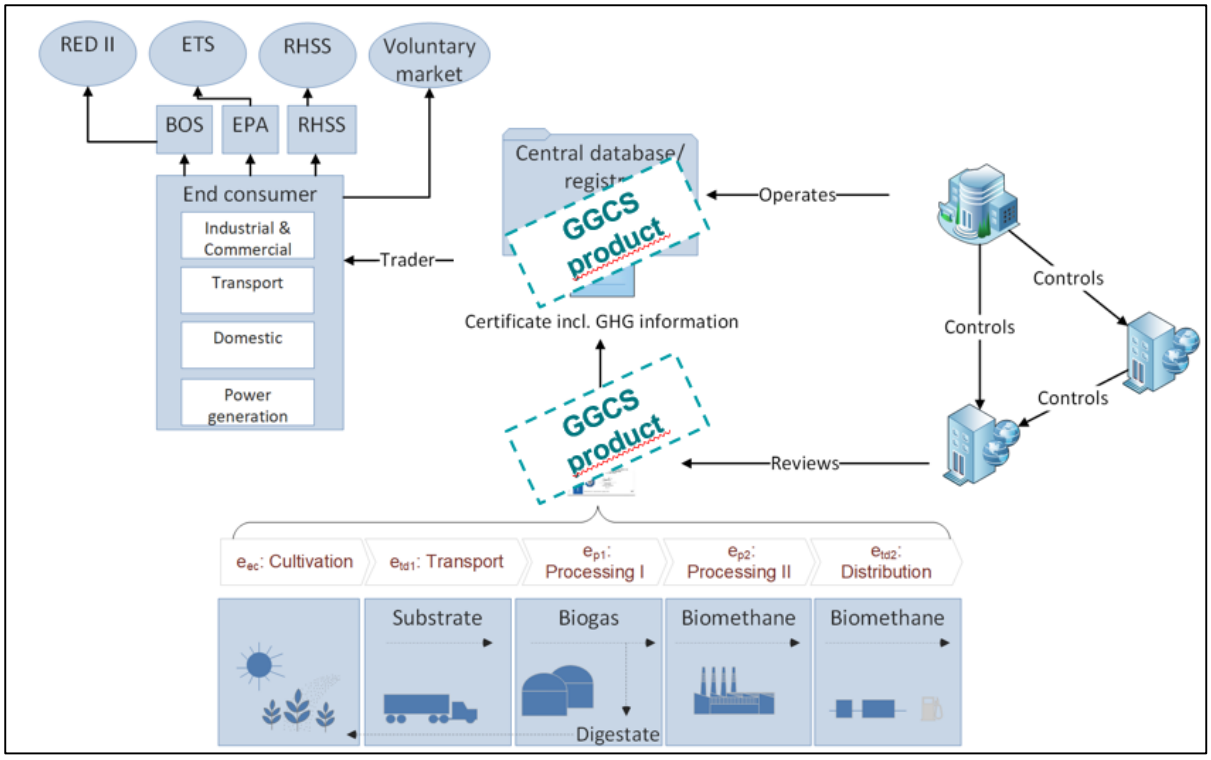


Figure 7: Schematic of Green Gas Certification Scheme Blueprint

Roll out of the GGCS will play a number of key roles for the industry:

- It provides comfort for the end consumer that any Renewable Gas purchased is from a verified source and can be used in any sustainability reporting they may be required to undertake.
- It provides policy makers with a verified data source for accounting towards national targets for Renewables and GHG Emissions reduction. Additionally, it has recently been confirmed by EUROSTAT that by tracing the end use of the certificates, this can be fully accounted for in terms of application against different RES sectors such as transport for example where specific binding targets may apply.
- It provides producers the opportunity to maximise the market value of their Renewable Gas by trading certificates on a voluntary basis, with possibility for trading with other EU countries in the future through the ERGAR(European Renewable Gas Association of Registries) hub project.

The GGCS design project was completed in mid-2018 with work now underway on delivery of the operational scheme itself, due for completion in early 2020.

Grid Connection Policy and Regulatory Arrangements associated with Grid Injection

Connection Policy

The Commission for Regulation of Utilities (CRU) announced in May 2018 their decision on the connection policy for Renewable Gas. This policy agreed a 70/30 split for capital cost of Grid Infrastructure for Renewable Gas, subject to an economic appraisal test.

Renewable Gas Regulatory Arrangements

Two separate modifications to the Gas Networks Ireland Code of Operations were progressed via the Code Mod Forum to facilitate Renewable Gas projects. The first relates to the introduction of the terminology of Renewable Gas into the Code and general housekeeping, whilst the second relates to a derogation to the allowable oxygen limit for Renewable Gas, from a current 0.2% per molar to 1%

per molar, on both the transmission and distribution network.

Connection Models

The waste sector will play a vital role in supporting the Renewable Gas industry in Ireland and it is likely that they will be one of the first to begin production of Renewable Gas. Domestic and commercial organic wastes by their nature are collected and driven to centralised depots for disposal. It is reasonable to assume that in the future this sector will choose to build their depots and associated AD plants in the proximity of the existing gas grid and look to connect directly via pipeline. However, if all the feedstock potential in the waste sector is maximised for use in AD this still only represents c. 4% of current Natural Gas demand. Achieving greater penetration of Renewable Gas will require accessing Ireland's most abundant feedstock resources through mobilisation of the agri-sector. Agriculture by its nature is rurally dispersed and feedstocks such as slurries are not cost effective to transport. As a result, despite Irelands massive resource potential from Agriculture only a small portion of this is readily accessible in close proximity to the existing National Gas Grid. To counteract this, Renewable Gas Forum Ireland are advocating the use of a Centralised Grid injection model.

The Centralised Grid Injection (CGI) Model

The illustration in Figure 8 outlines the two stage aggregation principle of the proposed CGI and Renewable Gas collection model. In the first stage, an AD co-digestion production process takes place at a location which is optimised based on immediately accessible feedstock local to the plant. At stage two, the biogas is purified on-site to a "grid entry ready" Renewable Gas (CH_4) specification. From here, the Renewable Gas is compressed and loaded into high capacity gas storage trailers. At stage three, the gas is transported via road to a centralised grid injection point on the network where finally at stage four, the gas is decanted from the trailer, depressurised and injected into the natural gas grid. Using this model each CGI point could support somewhere between 12 up to 20 AD plants in a given catchment area. Based on Gas Networks Ireland analysis the CGI Model is expected to show a positive price comparison versus the direct grid connection to projects producing less than 30 GWh/ annum with price differential depending on a function of distance from the network thereafter. Upon the roll out of CGI facilities across the gas network by 2030 it is anticipated that the entire Republic of Ireland will be within a CGI catchment area, except for Donegal and some small parts of Sligo and South Kerry. The CGI model is open to competition and can be owned/operated by third parties.

Benefits of the Centralised Grid Injection Model

1. Provides access for feedstocks not in the immediate proximity of the National Gas Grid.
2. Socialises the cost of the network entry facility across a number of plant operators.
3. Modern composite trailers can carry up to 110 MWh of gas per trip, resulting in low cost road transport costs for distances of up to 100 km.
4. Compressed renewable gas is a light weight and energy dense fuel which is much more cost efficient to transport compared to raw feedstocks such as slurry which is 94% water for example.
5. Renewable Gas transportation and injection is managed by a small number of parties with competencies in gas quality management and gas safety design, meaning the producer can focus primarily on the production of their renewable gas. This reduces their operating costs and liabilities.
6. Renewable gas producers availing of this model will contract on an operational charge with an entity to transport and inject their gas. This will reduce the amount of upfront capital costs required by the AD producer and assist in managing cash flows.
7. Minimises the socio – political impacts of hard infrastructure whereby using a direct connection model would require a pipeline running from each of the ~350 ADs needed to achieve 20% Renewable Gas, this can now be reduced into approximately 15 – 20 centralised connections.

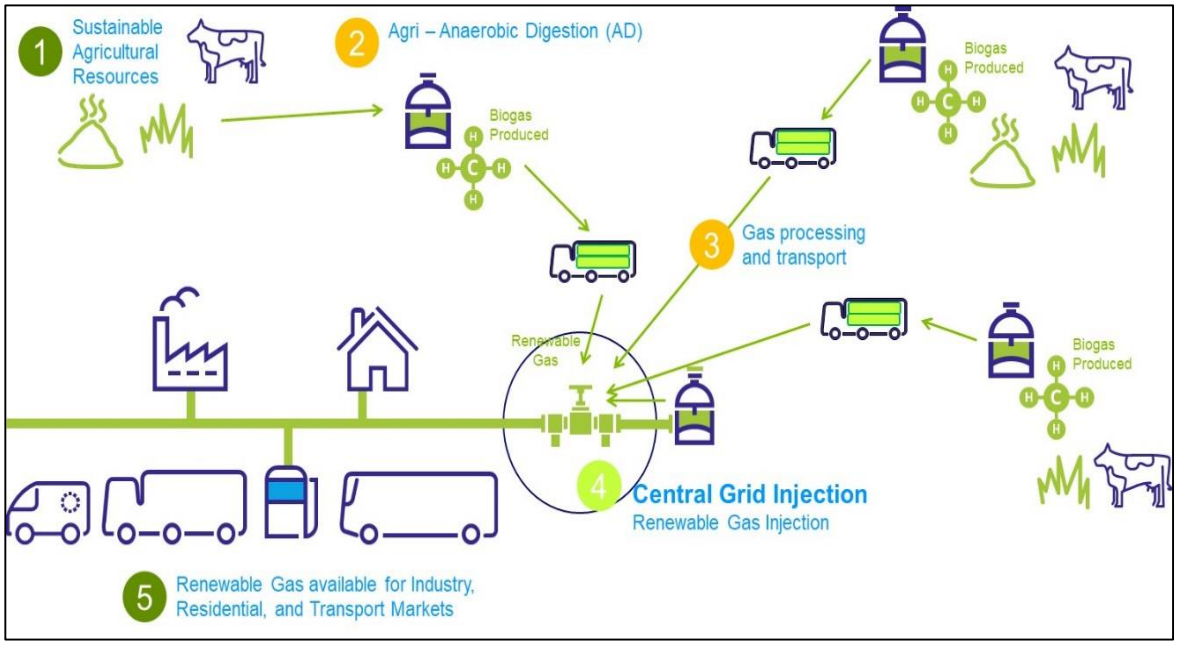


Figure 8: Gas Networks Ireland Illustration of Central Grid Injection model

Examples of the CGI and road transportation of Renewable Gas can be found in other countries operating under very similar international standards. Argentina, USA and Canada have the largest operational examples with Sweden, Austria and GB having the most examples in Europe. Scotia Gas Networks (SGN) commissioned their first CGI facility in 2017 at Portsdown Hill, pictured in Figure 9 below.

Figure 9: Scotia Gas Network Portsdown Hill CGI Facility

Irelands first Renewable Gas Injection Point

In early 2019, the Cush Network Entry facility located in Co. Kildare will become the first Renewable Gas entry point on the National Gas Grid in Ireland. The project is supported through a gas innovation funded

scheme and will act as a quarter scale demonstrator of the Centralised Grid Injection model in operation.

The site will be owned and operated by Green Generation, who own an existing AD plant in Nurney, Co. Kildare where they will upgrade the gas and transport it via road trailer unit to the Cush site for injection. When operational, the Cush site will have a capacity of 1,200 scm per hour (approximately 110 GWh per year if operated at maximum capacity)

Figure 10: Green Generation Production Site at Nurney, Co. Kildare

National Policy supports measures and drivers for Renewable Gas investment

As is the case with other renewable energy technologies, Renewable Gas requires financial supports to make it cost competitive with fossil fuel alternatives while the industry is being established. Based on RGFI cost of production analysis the following guaranteed price of production for a period of 15 years would be required to incentivise production in the industry. These tariffs are designed to decrease as scale of production increases to account for economies of scale.

Table 4: RGFI Cost of Production Estimations for Renewable Gas Producers

Tier Name	Criteria	Unit Price (€ / kWh)
Tier 1	Applies to the first **35**GWh / annum produced	**0.09**
Tier 2	Applies to all production in excess of **35** GWh / annum and less than **70** GWh / annum	**0.07**
Tier 3	Applies to all production in excess of **70** GWh / annum	**0.05**

Assuming a consumer price for Renewable Gas (Market Price of Natural Gas + Additional Renewable Commodity Value) of approximately €0.04 / kWh, this would require subsidisation of up about €500 million per annum to achieve a penetration of 20% blend renewable gas. However, despite this apparent cost to the exchequer, Renewable Gas can offer a positive net economic benefit to Ireland as a whole as expressed in Table 5 below.

Table 5: Cost Benefit Analysis of Renewable Gas in Ireland

Itemised Cost / Benefit	Description	Cost / Benefit (€m/annum)
Subsidisation Cost	Cost to support 20% Renewable Gas	**-500**
Avoided Fines Benefit	Alternative to paying fines associated with missing binding EU targets for 2020 (Note: Values of up to €600m per annum have been speculated as the cost of these fines)	**+120**
Carbon Reduction Value	Value of carbon abatement associated with 20% Renewable Gas (based on 2030 Carbon Predictions)	**+240**
Jobs Created	6,500 new long term jobs dispersed across rural Ireland	**+160**
Avoided Imports	Cost savings in reduction of imported fossil fuels	**+250**
Security of Supply	Reducing reliance on imported fossil fuels from UK and European supplies. De-risking for Brexit.	Undefined
Increased / Retained FDI	Mandatory requirement for 80% of FDI companies looking to locate and expand in Ireland post 2020. Renewable Gas to meet corporate targets and climate obligations	Undefined
Total		**+270**

Government funding support can be achieved through a number of possible avenues such as the ring fencing of carbon tax and / or through access to the €22 billion set out for Climate Action under the National Development Plan.

Carbon Taxation

It is estimated that the Irish gas consumer currently pays circa €126 million in carbon taxes on gas consumption per annum. Carbon taxes look set to increase over the coming years as stated publically by DCCAE. Utilising this fund to support the rollout of a Renewable Gas industry is both appropriate and has

been proven effective in other jurisdictions such as France where carbon taxes on oil and mineral fossil fuels are used to support an indigenous renewable gas industry, with the outcome of one new facility being rolled out every two weeks.

Project 2040 and the National Development Plan

Project 2040 sets out the strategic vision and priorities to support national, regional and local planning and investment decisions in Ireland over the next two decades, to cater for an expected population increase of over 1 million people. Over the next 10 years, roughly €22 billion has been set out to support climate action goals, representing almost 20% of the overall budget. Currently, the Irish government has received significant criticism of their current strategy for failing to tackling climate change and a revised approach is needed[17]. Allocating part of this fund towards supporting the roll out of a Renewable Gas industry offers policy makers an opportunity to make Ireland world leaders in climate action.

Obligations and Demand Driven Schemes

The use of an obligation scheme could be applied to the Renewable Gas sector additionally. Obligation schemes have been proven as an effective driver of demand in sectors such as transport via the Biofuels Obligation Scheme. However, it is the position of the RGFI that obligation / demand driven schemes are not the most effective way to mobilise production in an industry until a minimum market share can be achieved. First movers into the market need clear sight of their revenue streams in order to invest, hence the application of a guaranteed price per unit of energy produced is most effective in delivering this. This has been proven as an effective mobiliser across a number of other countries such as France and the UK, as well as here in Ireland through the application of the REFIT (Renewable Electricity Feed in Tariff) schemes to the electricity sector. The RGFI does not believe the application of an obligation to Renewable Gas should be applied until a minimum market share of 10 – 15 % has been achieved.

[17] https://www.irishtimes.com/news/environment/naughten-admits-plan-to-cut-carbon-emissions-is-not-working-1.3611689

Mobilising the Renewable Gas Industry

Mobilisation of an Irish Renewable Gas industry will require a strong and clear commitment of support from Irish policy makers and key stakeholders. Assuming this is forthcoming there are a number of additional key enablers to the development of the industry covered in this section.

Funding Projects

RGFI has set out a key objective to establish funding streams and instruments that will facilitate and enable the deployment of renewable gas projects throughout Ireland. RGFI have engaged with a number of fund managers with renewable gas industry expertise that are familiar with anaerobic digestion projects in other EU jurisdictions.

There are a number of fund managers that have a strong appetite, to provide a dedicated fund for the financing of renewable gas production facilities at competitive rates throughout the life cycle of the renewable gas production facility. The source of these funds will come from a variety of sources such as Strategic Investment Funds, European Investment Bank, Employment Incentive and Investment Schemes (EIIS), private funding and green investment funds.

RGFI are currently in advanced discussions on the proposed market arrangements for a Renewable Gas industry. As part of this consultation, it is proposed to establish a central strategic fund to provide capital support to the industry. This model will provide an opportunity in particular for local communities, individual or groups of farmers to come together in a cooperative model and own and operate their own plants, retaining the many benefits of Renewable Gas production within the local community.

Promotion and development of technical expertise

Despite reaching a high level of maturity in other EU countries, only a handful of Anaerobic Digesters exist currently in Ireland. Achieving 20% Renewable Gas (in the region of 300 – 350 AD plants) will require significant promotion and development of technical expertise in the sector. Of particular importance will be working with the agri sector whom have circa 90% of the AD feedstock potential. Working with key industry stakeholders and rural communities in this sector to promote the opportunity and ensure the resources required to upskill interested parties in the production of Renewable Gas are readily available will be required to achieve this target.

Optimising the Value Chain

Renewable Gas offers many unique benefits in addition to the production of a renewable and sustainable energy source which other technologies simply cannot match. Recognising and monetising these benefits will be a key driver to the long term viability of the industry. These benefits are highlighted below.

High quality bio-fertiliser production

Digestate is the main by-product of the Anaerobic Digestion process. It is made from the sludge of the organic feedstock material once it has been digested and the biogas extracted. As all the nutrients are retained throughout the anaerobic digestion process this organic fertiliser is naturally high in essential minerals such as Nitrogen and Phosphate making it an ideal alternative to the spreading of chemical fertilisers. A 35,000 tonne AD plant will produce roughly 28,000 tonnes of digestate output. It is estimated by the European Biomethane Association that 1 tonne of artificial fertiliser replaced with digestate saves 1 tonne of oil, 108 tonnes of water and 7 tonnes of CO_2 emissions[18]. Presently, most AD facilities in Ireland currently offer their digestate to local farms at no cost. Like with anything new there is a lack of understanding within the farming community of benefits and perceived risks associated with the spreading of digestate at present. The management of digestate from all AD plants is under strict regulations from the Department of Agriculture, Farming and Marine (DAFM) which generally requires plants to put all digestate through a pasteurisation process, killing off any chance of pesticides or disease spreading. Achieving recognition for these benefits and optimising the commercial value of this digestate product will be a key component in maximising revenue streams and reducing the need for subsidisation. The RGFI are currently working with a number of EU partners on a proposal for funding for a European bio fertiliser certification scheme which

[18] http://european-biogas.eu/wp-content/uploads/2015/07/Digestate-paper-final-08072015.pdf

could act to provide recognition and offer comfort to end users as to the quality of any digestate used.

Production of Green CO_2

When biogas is produced in the AD process it is about 60% pure methane, with the majority of the remaining 40% being Carbon Dioxide (CO_2). In order to make the gas suitable for grid injection the CO_2 component must be removed, resulting in a product >98% pure methane. Many AD plants currently release this CO_2 to the atmosphere, whilst still retaining a net carbon saving based over the lifecycle of production. However, there are upgrading technologies which allow for the capture and utilisation of this CO_2. Until recently the CO_2 market opportunities have been limited for AD producers with an excess of production existing. In June 2018, this all changed however with a number of big manufacturers closing their facilities creating a shortage of CO_2 across Europe[19]. Capture and processing of CO_2 from the AD plant into a product which is fit for application to food grade requires an additional upfront capital cost for plants, as well as increased energy required at the plant to purify and liquefy the CO_2 for resale. However, the carbon savings which can be achieved in doing so are significant, producing a "Green CO_2" product. Recognising this benefit and driving the market for Green CO_2 could prove a key component in the overall AD value chain. The combination of captured CO_2 with hydrogen produced via a Power to Gas process offers additionally synergies for Renewable Gas production which could be achieved through the capturing of Green CO_2.

Flexibility of application to different market sectors

Other renewable technologies such as wind or solar PV by their nature are a very cost effective way of decarbonising electricity. However they are not easily applicable to heat or transport unless a strategy of electrification is applied to these sectors, resulting in massive infrastructural changes and costs to society. Renewable Gas can be readily applied to all three sectors without any such need for intrusive retrofitting of heating systems for example. This flexibility allows Renewable Gas to be applied to the sectors most difficult to decarbonise, in a manner complementary to other renewable technologies. In order to achieve this outcome, the correct market signals must be sent to ensure Renewable Gas is utilised in the sectors deemed most difficult to decarbonise for the Irish government. In doing so, this should help to enhance the value chain for renewable gas.

Demand for Renewable Gas

The availability of renewable energy is a key consideration for Foreign Direct Investment (FDI) by companies seeking to invest or expand in Ireland. Most FDI companies now have declared corporate responsibility objectives relating to GHG emission reduction or renewable energy, with mandatory targets set for 2020 and beyond, and have implemented corporate policies aimed at carbon footprint reduction across their organisations internationally. Such companies are unwilling / unable to invest in new projects unless they have access to renewable energy in their energy mix. Some of the larger multinational companies have gone further and are now insisting on 100% renewable energy, or a growth plan to achieve this.

The primary fuel choice of these FDI companies is typically gas due to flexibility, efficiency and security of supply reasons. Unless Renewable Gas is available, many of these organisations will not have a cost effective alternative to decarbonisation due to the quantity and type of energy use on site. Unless Ireland can offer a carbon-neutral cost effective solution such as renewable gas there is a risk that many of these multinationals may look to expand or relocate operations to other nations who can.

Conclusion

The Renewable Gas Forum Ireland (RGFI) on behalf of the Renewable Gas supply industry has worked proactively over the last number of years to establish the fundamentals required to enable an indigenous renewable gas industry to flourish. This work has involved establishing a Green Gas Certification Scheme which will provide the end gas consumer re assurance and confidence that the renewable gas they procure is subject to a robust verification and auditing process, establishing a connection policy for renewable gas and the removal of numerous potential regulatory and technical barriers which could restrict the rollout of the industry more generally.

[19] https://www.irishtimes.com/business/co2-shortage-sparks-fears-over-summer-beer-supplies-1.3537160

Ireland has a unique opportunity available to decarbonise through Renewable Gas, having the largest potential in Europe to produce biomethane by 2030. Renewable Gas, using Anaerobic Digestion, is a well proven matured technology which has been shown time and time again to assist significantly in decarbonising the renewable electricity, heat and transport sectors across Europe. Unlike alternative renewable technology options, Renewable Gas has many added benefits which make it unique. No other renewable technology solution can offer the same level of benefits in terms of decarbonisation of agriculture, creation of jobs and benefitting the rural economy, setting Renewable Gas apart from alternatives.

Large consumers in the biopharma, manufacturing and processing industries currently rely heavily on Natural Gas to sustain their operations. Without offering a suitable carbon neutral alternative in the form of Renewable Gas, many of these industries may be forced to look to alternatives outside of Ireland to ensure adherence with their decarbonisation targets for 2030 and beyond.

Renewable Gas roll out has been shown to provide a net economic benefit to Ireland Inc. as a whole. However, for producers to invest, the Irish Government must provide clear political supports and ensure the correct market conditions are in place to support the large scale penetration of a Renewable Gas industry in Ireland.

A specific Biomethane Support Scheme, as recommended by Element Energy, the independent consultants commissioned by government to assess the potential of Biogas and Biomethane, is considered to be the most effective way to mobilise Ireland's potential, and has been proven in other jurisdictions already. The Renewable Gas Forum of Ireland calls on the Irish government to progress the implementation of this support scheme, allowing Ireland Inc. to make the most of this unique opportunity which is available to them, becoming a world leader in sustainability and renewable energy in the process.