An Taisce
The National Trust for Ireland

Commission for Regulation of Utilities,
The Exchange,
Belgard Square North,
Tallaght,
Dublin 24

Sent by email to:
pbyrne@cru.ie

01.02.19

Re: CONSULTATION ON GAS NETWORKS IRELAND TEN YEAR DEVELOPMENT PLAN BY COMMISSION FOR THE REGULATION OF UTILITIES

Dear Sir/Madam,

An Taisce welcomes the opportunity to take part in this public consultation on the Gas Networks Ten Year Development Plan by the Commission for the Regulation of Utilities. We would like to raise the following issues:

1.0 PRELIMINARY CONSIDERATIONS ON LEGAL OBLIGATION ON COMMISSION FOR REGULATION OF UTILITIES

1.1 EU Directive 2009/673/EC and SI 16 of 2015 on Energy Eegulation and Aarhus Convention

This consultation is advertised under Article 22 EU Directive 2009/673/EC and SI 16 of 2015 on energy regulation.

Article 1(2) of the Directive includes a provision in relation to climate protection providing that:

> "*Having full regard to the relevant provisions of the Treaty, in particular Article 86 thereof, Member States may impose on undertakings operating in the electricity sector, in the general economic interest, public service obligations which may relate to security, including security of supply, regularity, quality and price of supplies and environmental protection, including energy efficiency, energy from renewable sources and climate protection.*"

Directors: Karl Dowling (Secretary), Philip Kearney, Christopher Massi, Muiris O'Ceidigh, Patricia Oliver, Judy Osborne (British), John Pierce (Chair), Garrett Poynton, Charles Stanley-Smith (British), John Sweeney.

Article 22(4) contains specific provision on the consultation process to be undertaken by the regulator to include actual or potential systems users:

> *"The regulatory authority shall consult all actual or potential system users on the ten-year network development plan in an open and transparent manner. Persons or undertakings claiming to be potential system users may be required to substantiate such claims. The regulatory authority shall publish the result of the consultation process, in particular possible needs for investments*"

A key part of effective climate action and decarbonisation will be the engagement of the public at large and energy consumers in energy efficiency and replacement of fossil combustion with renewables. This is best achieved by promoting the concept of energy citizens instead of consumers. This would allow all energy users to generate and provide surplus renewable energy to the grid through community-based or co-operative partnerships in energy conservation and generation in which the Tipperary Energy Institute has set leadership in Ireland.

The definition of "*potential system users*" under the 2009 Directive accordingly needs to be applied to individuals and households, community organisations, environemtnal and sustainable development NGOs . The EU and its Member States are parties to the Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters.

Link: http://ec.europa.eu/environment/aarhus/legislation.htm

The Decision on conclusion of the Aarhus Convention by the EC was adopted on 17 February 2005 [Decision 2005/370/EC]. The EC is a Party to the Convention since May 2005.

Both Directives 2003/4 and 2003/35 contain provisions on access to justice.

Most relevant to the public consultation issues raised by the submission of the GNI TYNDP is Regulation (EC) N° 1367/2006 of the European Parliament and of the Council on the application of the provisions of the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters to Community institutions and bodies (OJ L 264, 25.9.2006, p.13) entered into force on 28 September 2006 and into application on 17 July 2007.

It is submitted that the determination by CRU of the GNI TYNDP constitutes environmental decision making. The public notice and consultation provided by CRU do not meet Ireland's Aarhus obligations.

1.1.2 Strategic Environmental Assessment Directive (SEA) 2001/42/EC and Appropriate Assessment under the Habitats Directive 92/43/EC

There is an onus on consent on Regulatory bodies including CRU to comply with EU and national law. This includes direct application where explicit provision is not in place.

In the case of this consultation, the making of a screening determination by the GNI for SEA is required on the Draft GNI TYNDP. The basis of the TYNDP relates to a ten year strategy with major implications for health, climate action, land use and biodiversity which requires SEA.

A major element of the Draft TYNDP is the sourcing of increased production of biomethane from animal slurry and land-based crops, including grass to a level of up to 20% content of gas consumption by 2030. This has major implications for biodiversity in increasing pressure for land use change and on habitats and species, nitrate fertilizer impact, and ammonia emissions.

It is submitted that Appropriate Assessment is required under the Habitats Directive.

1.1.3 Climate Action and Low Carbon Development Act 2015

The Climate Action and Low Carbon Development Act 2015 Section 15(1)(d) under 'Duties of Certain Bodies' states that a:

> "*Relevant body shall in the performance of its function have regard to a range of considerations including:*
>
> *(d) the objective of mitigating greenhouse gas emissions and adapting to the effects of climate change in the state.*"

This provision applies to all State and Public Bodies including the Commission for Regulation of Utilities ("**CRU**"). While the CRU has been established with a specific statutory remit relating to pricing and regulation, Section 15 of the Climate Action and Low Carbon Development Act 2015 is an overarching obligation to ensure achievement of the low carbon future. Moreover, under the EU Governance Regulation of the Energy Union and Climate Action, published in December, 2018: by 1 January 2020 "each Member State shall prepare and submit to the Commission its long-term strategy with a perspective of at least 30 years" and the "The Member States' and the Union's long-term strategies shall contribute to ⋯fulfilling the [temperature] objective of the Paris Agreement. This means that Member States and their agencies will need to coherently plan and achieve substantial and sustained reductions in total annual energy emissions to limit to limit cumulative emissions in line with the Paris objective.

2.0 OVERARCHING QUESTIONS RAISED IN CONSULTATION

The CRU is appropriately seeking response to the overarching considerations set out in the consultation call in response to Gas Networks Ireland ("**GNI**") Draft Ten Year Network Development Plan ("**TYNDP**") [2017/18 to 2026/27].

1. Commentary on the long term role of the gas network and the role that the gas network will have in the future as Ireland moves to a decarbonised economy;

2. GNI's focus on the following with regard to the future use of the gas network: • Compressed Natural Gas; • Renewable Gas; • Smart metering; • Carbon capture and storage; • Power to gas; and • Hydrogen utilisation of the gas grid;

3. Potential energy options that have not been considered by GNI in the draft NDP;

4. Other energy options that may affect GNI's assumptions in the NDP; and

5. The estimated gas demand anticipated by GNI post 2027.

2.1 THE LONG TERM ROLE OF THE GAS NETWORK AND THE ROLE THAT THE GAS NETWORK WILL HAVE IN THE FUTURE AS IRELAND MOVES TO A DECARBONISED ECONOMY.

2.1.1 The Gas Industry is not an Appropriate Source to Model Future Development Projections

The GNI TYNDP is not fit for purpose as it is not based on any external or independent assessment of the sustainable future of gas, and the gas pipeline network in a low carbon future. The study is based on a ten year time frame only and does not address the level of emission cuts which will be required through to 2030 and beyond to meet Ireland's carbon budget, and the level of fossil fuel emissions reduction which Ireland will need to achieve to meet the commitments made under Paris Agreement. GNI did recently publish a "Long Term Resilience Study" document showing projections of fossil (natural) gas and potential biomethane use until 2040, however, a preliminary analysis at Dublin City University of its energy and emissions implications finds that "the LTR Study claim that its medium demands scenario is aligned with Ireland reaching long-term decarbonisation targets appears highly questionable in terms of Ireland's fair share carbon quota and even in terms of published least cost analysis".

GNI is an entity whose remit is the maintenance and development of gas infrastructure. Its TYNDP is based on the uncritical assumption of accommodating continued increased gas demand.

GNI, in common with gas industry interests across the EU is promoting the concept of injecting a quantity of agriculture or crop based bio methane into the existing fossil gas network, and unjustifiably branding this "renewable gas". In Ireland biomethane projections are predicated on maximising nitrogen fertiliser use on land to grow more grass (in addition to the 35% increase in N-fertiliser use already seen since 2010 for herd expansion), thereby increasing nitrous oxide (N_2O) GHG emissions even further. Adding the effect of methane leaks from anaerobic digesters means that the effect of these potent GHGs is likely to greatly reduce or cancel the claimed CO_2 climate benefit of using biomethane instead of fossil fuels. This so called renewable gas is also problematic in supply sustainability, competing with food production for land, and will not achieve the level of emission reduction needed to meet Paris Agreement implementation targets. It perpetuates and prolongs a lock-in to fossil gas infrastructural development and consumption, and inhibits investment and deployment of low carbon renewable alternatives, particularly for heating and transport.

This is outlined in a Corporate Europe 2018 report. Link to report:
https://corporateeurope.org/climate-and-energy/2018/10/part-1-dangerous-distraction-renewable-gas-keeps-us-fossil-fuel-path

The report also highlights the nature and extent of the industry lobby behind so-called renewable gas.

In the UK there is a National Infrastructure Commission which evaluates the future of infrastructure. Itis independent of the utilities or state body, or corporate interests involved. In its 2018 report the UK National infrastructure Commission questioned the viability use of gas for heating in meeting emission reduction targets after 2030, with the alternatives of investment in efficiency and renewable electric powered heat pumps or hydrogen replacing fossil gas electricity generation.

> *"There are two potential large scale solutions for low carbon heat, and a range of smaller solutions which may complement one of them. The first option is electrification, using heat pumps to increase the efficiency of using electricity for heating. Alternatively, hydrogen from a zero carbon source (which creates only water vapour when burnt) could be used as a direct replacement for natural gas, fuelling boilers and appliances.*
>
> *Whilst there are incremental steps that can be taken to address some aspects of the challenge, an incremental approach on its own will not be enough. In the 2020s, decisions will be required on whether the gas network should be maintained and converted, or phased out*" (P.g. 45 Link:

https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf)

This puts into question any expansion of the gas network or any justification of seeking to attract new gas consumers to lock into fossil combustion heating systems or vehicles, as GNI is doing in its current strategy and advertising campaigns.

To be read in conjunction with this submission, we attach an independent expert peer review, "*Is Natural Gas Essential For Irelands Future Energy Security*", commissioned on behalf or Stop Climate Chaos (Appendix 1). This report was produced in response to an Irish Academy of Engineering report seeking to justify continued oil gas exploration in Irish territorial waters.

GNI does not address the global threat to fossil fuel infrastructure in becoming a stranded asset through the combined need for rapid energy decarbonisation, and development of alternative technologies.

We have set out an overview on the issue of redundant fossil fuel infrastructure in the attached **"A STRANDED ASSET"** in looking at the future of the Irish Gas Infrastructure. **(APPENDIX 2)**

There is the historic precedent of the rapid speed with which gas electric lighting was superseded by electric lights in the early 20th century.

2.1.2 GNI Demand Forecast Methodology

GNIs modelling of gas demand as set out in its "*Methodology for Forecasting Gas Demand"* published in 2018 with the ten year study does not represent in any way a sustainability assessment of current, continuing and future gas consumption.

Link: https://www.gasnetworks.ie/corporate/company/our-network/network-development-plan/Methodology-for-forecasting-gas-demand-(1).pdf

GNI, while State owned and coming under the Minister for Communications Climate Action and the Environment has a vested interest in expanding the use of fossil gas and is no different to any commercial entity or service provider seeking to maintain and expand its product or service based primarily on maintaining and increasing consumer share and numbers. On behalf of the public good its forecasting should be treated with due caution by regulators and decision-makers.

For example in relation to projecting residential one of the main considerations in its demand methodology is historic data and "*The new house/apartment split, based on historical trends*".

This does not address the higher insulation standards for new housing stock and the alternative of renewably powered electric heat pumps instead of gas boilers.

2.1.3 Branding of Gas Production and Combustion as "Clean"

The marketing and branding of GNI repeatedly refers to gas as a clean fuel. This constitutes misleading advertising since it does not address the GHG emission impact of gas production and combustion whether it be fossil gas or agricultural or crop-based biomethane. Methane is 75% carbon by mass and unabated combustion of fossil carbon needs to go to zero over the next 30 years. Contrary to this physical climate reality, GNI's LTR study indicates that increased use of fossil gas will in fact maintain energy system emissions at the current very high level. The use of biogas will do little or nothing to assist decarbonisation and is all too likely to act as 'greenwashing' for increased fossil gas use.

The development of a gas vehicle infrastructure to substitute for petrol and diesel vehicles is being advanced on the basis of gas being "clean".

The 2018 Report by Brussels-based NGO, Transport and the Environment on gas for transport raises signficant issues on air pollution impact.

> "*There are only limited air quality benefits from using fossil gas in road transport. Gas vehicles perform similarly to petrol cars and only marginally better than diesel cars in terms of compliance with the new RDE limits. The European Commission is working on a Euro 7 limit which will further decrease or entirely eliminate any benefit gas has over diesel cars. Far greater air quality improvements could be achieved by switching to zero emission cars.*
>
> *For trucks, CNG and LNG offer no meaningful benefits (NOx, PM) compared to vehicles complying with the Euro VI standard. HPDI (high pressure direct injection) truck technology has slightly higher NOx emissions. Particle number emissions are also higher in methane-powered transport, compared to diesel. For ships LNG has a clear benefit compared to heavy fuel oil although similar emissions performance can also be achieved by fitting ships with after treatment systems such as SCR and DPF and using low Sulphur marine gas oil*."
>
> Link to T&E 2018 Report:
> https://www.transportenvironment.org/publications/natural-gas-powered-vehicles-and-ships-%E2%80%93-facts

2.2 GNI'S FOCUS ON THE FOLLOWING WITH REGARD TO THE FUTURE USE OF THE GAS NETWORK: • COMPRESSED NATURAL GAS; • RENEWABLE GAS; • SMART METERING; • CARBON CAPTURE AND STORAGE; • POWER TO GAS • HYDROGEN UTILISATION OF THE GAS GRID

2.2.1 Compressed Natural Gas

There is no climate mitigation or business case for promoting or developing compressed natural gas infrastructure. The use of compressed natural gas ("**CNG**") in transport will not achieve the level of emission cuts required. Developing CNG infrastructure would perpetrate the continued extraction and combustion of fossil gas lock in, and impede the alternative of electric transport from renewable energy generation.

In its own promotional information advocating CNG for transport, GNI is able to claim only a 22% reduction in fossil emissions.

The European NGO Transport and Environment (T&E) has carried out extensive research on the sustainability of CNG and use of biomerthance for vehicles.

> *" The EU has agreed to cut its greenhouse gas (GHG) emissions by at least 80-95% by 2050 and was the driving force behind the Paris Agreement which requires net zero emissions by the middle of the century. Climate policy will require a shift away from petroleum which currently provides nearly all of transport's energy needs. Apart from a transition towards zero emission technologies such as battery electric or hydrogen, regulators and governments across Europe are considering what role gas could play in decarbonising transport.*
>
> *The EU and several national governments support the use of methane in transport through regulations, tax breaks and subsidies. The gas industry - which is faced with stagnating or declining demand in other sectors in Europe – sees transport as a major growth market.*
>
> *This report compiles the latest evidence on the environmental impacts of using gas as a transport fuel. The report is based on the most up to date literature, test results and data. It builds on a previous report by AEA-Ricardo but analyses in more detail issues such as the role of renewable methane (biomethane and power-to-methane) or the impact of tax policy.*

Climate impacts

Gas vehicles and vessels have similar performance to other fossil fueled vehicles and vessels. Based on the latest available evidence fossil gas used in transport has no meaningful - and when including methane leakage and upstream effects in almost all cases - no climate benefits compared to petroleum-based fossil fuels.

The overall (well to wheels/WTW) GHG performance identified in this study (with the medium upstream emissions) range from -12% to +9%, depending on the mode of transport. In cars, the GHG savings range from -7% to +6% compared to diesel. In heavy duty, the range is -2% to +5% compared to best in class diesel trucks and depending on the fuel and engine technology. In shipping, the figures are -12% to +9% compared to marine gas oil (MGO) but these figures are highly dependent on methane slip.

We did not find any evidence supporting the theoretical savings of gas vehicles, which are based on the lower carbon content of the fuel. In reality poor gas engine efficiency often offsets the benefit of the fuel already at tailpipe level. This points to the need for policies based on measured performance (through the EU's official tests), not the type of fuel. Uncertainties also exist regarding methane leakage at the vehicle level and the impact of boil-off and venting is not well documented but could have a significant negative impact on gas vehicle's environmental performance.

Methane is a very powerful greenhouse gas. Over a period of 100 years it is 28 times more potent than CO2. In 2010 methane accounted for 20% of global GHG emissions. These (550 Mt) emissions are growing annually by 25 Mt, with 17Mt of the growth linked to fossil fuel extraction.

Methane leakage - i.e. unburnt methane leaking into the atmosphere - occurs throughout the supply chain (extraction, transport, refueling) and has a large and negative climate impact. Currently the average fugitive methane emissions in the supply chain of fossil gas are 2.2% of fossil gas produced, ranging from 0.2% to 10%.

Recent evidence suggests that upstream methane emissions have been significantly underestimated - by up to 60%, making it likely that CNG/LNG upstream emissions and subsequently well-to-wheel or wake GHG emissions are worse than the abovementioned numbers (which are based on 'central' upstream emissions data). Given that methane is a very potent short term greenhouse gas any benefits from gas vehicles would only materialise several decades into the future, well after the EU economy would need to be fully decarbonised." **Link to T&E 2018 Report: https://www.transportenvironment.org/publications/natural-gas-powered-vehicles-and-ships-%E2%80%93-facts**

2.2.2 Renewable Gas

There is no "renewable" gas source, as all models require a production chain and have an emission path. Biomethane is not a genuinely renewable energy source whether produced from animal effluent or a crop such as grass, and there is major GHG impact from the fertilization of grassland or other crops, as well as other emission leakages. Gas produced from waste is not renewable, especially if it monetises unsustainable agricultural practices. In any case, overarching sustainability policy including the UN SDGs provides for the reduction of waste, therefore any by-product capacity from waste will become more limited in the future.

There is no potential for biomethane to be either available in the quantity which would be required, or to be sustainably sourced to achieve the level of emission reduction which the Irish Carbon Budget requires.

The potential of sustainably produced bio-gas of any scale remains unresolved. In the short-term, as with biofuel dilution, there is a risk that the insertion of a "sustainable" bio-gas content into the gas grid could create a new generation of lock- in investment into gas-based technologies, without being able to achieve the progressive real decarbonisation needed thereby impeding alternative technologies including renewablepowered electricity.

GNIs own projections are to achieve a 20% biomethane injection into the fossil gas grid by 2030. The sustainability of producing this quantity of biomethane has not been justified, let alone the progressive increase that would be needed to meet the post 2030 carbon budget. Any consideration of the potential for a percentage biomethane injection as a way to justify maintaining a distributed gas grid and promoting continued use of gas for heating or transport requires vetting of financial, administrative, land use, air pollution and climate impacts. It is important to avoid any misdirected subsidy or energy support as occurred with the Northern Ireland Government's "Cash for Ash" scheme.

The 2018 Transport and the Environment (T&E) report on Gas-powered vehicles contains extensive consideration on biomethane. An overview is sent out in the Executive Summary, which states the following:

> *"Biomethane and power-to-methane can have (significantly) lower GHG emissions than fossil gas. However, sustainable feedstocks for biomethane (wastes, residues) are very limited and cannot be sustainably scaled. Even if we assume the maximum sustainable potential is produced and all of it is allocated to transport - this is very unlikely to happen - biomethane could only cover 6.2- 9.5% of transport's energy needs. Currently, only around 4% of gas consumed in the EU is renewable, and this is mainly produced from crops such as maize. The gas grid has just a 0.5% share of*

renewables, compared to almost 30% of renewables in electricity generation. Less than 1% of biogas produced is currently used in transport.

Crop-based biogas (e.g. from maize) is associated with significant indirect land use change emissions. These impacts eliminate most of the GHG benefits compared to fossil gas. In addition there are issues relating to biodiversity and competition with food. This is why crop-based biogas is capped for transport purposes under the Renewable Energy directive.

Electricity-based methane (power-to-methane) is inefficient and expensive (at least 5 times dearer) to produce and would greatly increase demand for renewable electricity. Renewable electricity is turned first into hydrogen and then into methane. The process efficiency is now roughly 40%, potentially increasing to 60% in a future best case, and requires considerable additional renewable electricity, which is currently not going to be available at the scale required.

This means the contribution of renewable methane will be limited. What potential exists might be better used to help decarbonise sectors that currently depend on methane (residential, industry, power) and where no new infrastructure and engines are needed. Biomethane in transport can play a niche role in local projects, with vehicles running on 100% biomethane, refueling at local biomethane production sites. A wider shift to methane will almost certainly lead to a transport sector powered by fossil gas, not renewable methane".

Link to T&E 2018 Report:
https://www.transportenvironment.org/publications/natural-gas-powered-vehicles-and-ships-%E2%80%93-facts

2.2.2.1 Biomethane Capacity in Ireland

There are major sustainability issues raised by GNI projections to achieve a 20% target for biomethane injection into the fossil gas system. This figure does not address the impact of biomethane production on climate. The ammonia, nitrate and general land use impact of Irish bovine agriculture require a reduction in herd numbers.

The GNI modelling is based on feedstock availability projections combining, food-waste, animal slurry and grass crop biogas which are not tenable.

FOOD WASTE

Food waste is an unsustainable waste of food nutrition. Enhanced food management is required to reduce current levels of food waste, which would substantially reduce any projection of biogas recovery from food waste. The EU and Member States are committed to meeting the Sustainable Development Goals ("**SDGs**"), adopted in September 2015, including a target to halve per capita food waste at the retail and consumer level by 2030, and reduce food losses along the food production and supply chains. Food waste prevention is an integral part of the Commission's new Circular Economy Package to stimulate Europe's transition towards a circular economy which will boost global competitiveness, foster sustainable growth and generate new jobs.

For food waste that continues to arise the most sustainable use needs to be determined. It has not been established that anaerobic digestion is the most sustainable use. There is a need to develop alternative compost to replace the current use of peat in horticulture, and the use of plant-based food waste is a potentialalternative.Link: https://ec.europa.eu/food/safety/food_waste/eu_actions_en

CATTLE SLURRY

Agricultural GHG increased by 2.7% in the most recent EPA reporting period for 2017 resulting from the continuing increases in the bovine herd. Current levels of bovine herd increase are incompatible with climate action, both globally and nationally, which require an increase in plant-based food production and a reduction in the bovine herd because of methane emission impact that is not capable of mitigation.

"*Not So Green - Debunking the Myths Around Irish Agriculture*". 2016 Stop Climate Chaos and the Environmental Pillar. Link: http://www.antaisce.org/sites/antaisce.org/files/not_so_green_report.pdf

PIG SLURRY

Pig slurry is a major potential single ingredient for anaerobic digestion nationally. Given the concentration of pig farms into larger facilities and their geographic clustering, the first option should be to provide for an AD facility within the pig farm, or in close proximity to a cluster of pig farms and use of the biomethane created for electricity generation. There is a cumulative impact of industrial pig farming in conjunction with chicken farming with that in Northern Ireland exceeding Ireland's ammonia threshold limit, which constrains further industrial farming.

GRASS SILAGE

The sustainability of grass silage cultivation for anaerobic digestion has not been demonstrated. The current bovine herd increase is running into fodder availability limit and given the issues that arose in 2013 with the fodder crisis, and the fodder shortage during the 2018 drought, the reliability of an annual silage surplus for digestion cannot be guaranteed, if existing herd level continue to increase or are even maintained at current levels. Furthermore if grass is to be used as an energy crop it needs to be determined whether it is the most efficient in energy return compared to other energy crops or crops which would sequester carbon such as flax or hemp-based material for building insulation.

INDUSTRIAL FOOD WASTE

As with general food waste future policy and action is required to reduce current levels of industrial food waste. For industrial food waste that continues to arise the most sustainable use needs to be determined. It has not been established that anaerobic digestion is the most sustainable use. There is a need to develop alternative compost to current use of peat, and use of plant-based food waste is a potential ingredient.

2.2.3 Smart Metering

Any measure to reduce energy consumption and secure the more efficient use of energy is welcome. GNI has not demonstrated that smart metering, while desirable, either individually or in combination with other measures such as biomethane injection into the fossil gas distribution grid will achieve the level of decarbonisation required.

2.2.4 Carbon Capture and Storage

Irish CCS capacity of about 330 $MtCO_2$ at favourable low pressure is said to be available in the nearly-exhausted Kinsale Gas field. However, even if made available before 2030, near-term emissions of oil and gas alone are likely to have already by then used up Ireland's fair share of the global carbon budget for the Paris objective. Increasing fossil gas usage to the level projected by the GNI LTS study would then mean the entire Kinsale Field capacity would be use up by gass CCS within 10 years. International research and information has failed to project any achievable level of carbon capture and storage at the scale of, or within the time frame needed to achieve Paris-aligned decarbonisation unless near-term deep and rapid reduction of fossil fuel combustion is first achieved without delay. The continuation of current levels of fossil fuel consumption and continuing investment in combustion whether

for power generation or and of pipe level such as home gas boilers, cannot be justified on the basis of an uncertain future mitigation availability.

2.2.5 Power to Gas

We refer to the paper submitted as Appendix 1 of this submission in relation to the issue of future gas capacity for gas to power. As part of the resolution of Ireland's Carbon Budget and emission pathway for gas combustion generated emissions a strategy is required to determine the continuing role of gas in power generation.

This would need to consider the optimum use of any sustainably produced bio methane.

2.2.6 Hydrogen Utilization of the Gas Grid

Hydrogen is one of a number of potential technologies to fill the gaps in intermittent or variable wind and solar power generation. Hydrogen generation requires an energy input and has a pressure with different storage and transport requirements to natural gas or biomethane.

If a cost effective technology can be developed for large scale hydrogen production using surplus, including night-time renewable energy, in comparison to other options, then its optimum use would be as storage for electricity generation in flexible power plants able to meet renewable intermittency gaps. The potential or justification of injecting sustainably produced hydrogen into the gas grid has not been demonstrated.

2.3 POTENTIAL ENERGY OPTIONS THAT HAVE NOT BEEN CONSIDERED BY GNI IN THE DRAFT NDP.

The focus of the GNI strategy is accommodating current and increased demand rather than demand reduction.

GNI is no different to a commercial entity seeking to expand its turnover and market share. It does not address alternative investment priorities which should be in reducing heating demand and therefore gas consumption through retrofitting and other heating technologies such as electric heat pumps. The overriding need is for a national retrofitting scheme funded by direct grants, tax relief and loans integrated with "pay and save" schemes.

GNI is seeking to obtain and exploit bio-based material for injection into the gas grid. Sustainable use of bioenergy is in district heating schemes including heating from Combined Heat and Power ("**CHP**").

The risk of creating new dependence on individual gas boilers needs to be considered. Current assumptions by GNI that an increasing quantity of "renewable" gas can be inserted into the grid, or that future gas electricity generation can have viable carbon capture, have not been validated.

Creating a new lock-in of dependence on gas heating, particularly of boilers at individual household level, undermines alternative renewable heating systems, heat pumps and development of district heating, geothermal or other systems.

2.4 OTHER ENERGY OPTIONS THAT MAY AFFECT GNI'S ASSUMPTIONS IN THE NDP

GNIs assumptions are based on current energy costs and current carbon pricing. GNI is not modelling the decreasing cost of wind and solar technology and international research on emission and cost efficient storage to resolve renewable intermittency.

GNI is promoting the use of gas-based CHP for data centres, which are major energy consumers with contacts already in place with two data centre operators. The efficiency and emission impact claims made by GNI need to be externally assessed and comparison made with a comparable data centre sourcing wind and solar generated electricity from the grid.

GNI has not advanced any sustainability or business cases for gas boilers in new buildings, where insulation standards should obviate the need for gas systems, and heating need can be accommodated by electric heat pumps or other electric or ground source heat pump technology.

2.5 THE ESTIMATED GAS DEMAND ANTICIPATED BY GNI POST 2027

The gas demand projected by GNI to 2027 is based on the accommodation of current market consumptions and promotion of increased demand, for which GNI is carrying out a continuing advertising campaign.

Any projection of demand to 2027 must demonstrate a rapid descent in Ireland's energy and land use GHG emissions. It is not sufficient to just to look to 2027. It is necessary to look beyond that in order to achieve rapid emission reductions. For this reason the impact of achieving shortterm emission reduction with gasbased technology must be set against the danger of "lock-in" to gas infrastructure which inhibits more sustainable alternatives and does not achieve the progressive emission cuts needed beyond. This would leave investment in extended pipelines, including at consumption point in heating system and vehicles redundant.

Post 2030 a potential role for fossil gas can be modelled for Flexible Generation gas thermal stations ("**FLEX Gen**") to resolve renewable intermittency, if other more emission efficient technologies are not viable or in place.

Modelling of increasing fossil gas consumption on 2018 levels and promoting fossil gas for other uses cannot be justified, with a clear date needing to be established for the progressive reduction of GHG emissions from fossil gas as part of Ireland's overall carbon budget.

Any sustainably produced biomethane would most appropriately be used in electricity generation, local/district heating system or in an industrial plant in the local area of its production .

3.0 REQUEST FOR RESPONSE

An Taisce requests information as to what action the CRU proposes to take on this preliminary legal and other consideration raised in this submission.

Yours faithfully,

Ian Lumley,

Avocacy Office
An Tasice – The National Trust for Ireland

APPENDIX 1

Is Natural Gas "Essential for Ireland's Future Energy Security"?

A Critical Response to the Irish Academy of Engineering

Barry McMullin[*], **Paul Price**[†], **James Carton**[†], **Kevin Anderson**[‡]

[*]Dublin City University. Corresponding author: barry.mcmullin@dcu.ie

[†]Dublin City University

[‡]Universities of Manchester and Uppsala, and the Tyndall Centre for Climate Change Research

November 2018

An independent expert peer review commissioned on behalf of **Stop Climate Chaos**, a coalition of civil society organizations campaigning to ensure Ireland does its fair share to tackle the causes and consequences of climate change.

www.stopclimatechaos.ie

"Pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (high confidence). ***These systems transitions are unprecedented in terms of scale****, but not necessarily in terms of speed,* ***and imply deep emissions reductions in all sectors, a wide portfolio of mitigation options and a significant upscaling of investments in those options*** *(medium confidence)..."*

— IPCC Special Report on Global Warming of 1.5 °C, October 2018 (IPCC 2018 Headline Statement C.2, emphasis added)

"The findings of the IPCC highlight that ***only the most ambitious action possible will mitigate the adverse effects of climate change on human health and welfare*** *and that the time left to act is extremely limited.* ***While neither the 1.5°C or well below 2°C targets of the Paris Agreement are wholly consistent with the human rights obligations of States*** *acting together in accordance with the duty of international cooperation, to protect human rights from the adverse effects of climate change,* ***they do represent a ceiling that States have agreed should not be exceeded.****"*

— Statement by the UN Special Rapporteur on Human Rights and Environment, October 2018 (Boyd 2018, emphasis added)

Executive Summary

It is widely recognised that the current Irish energy system carries a significant security-of-supply risk, due to heavy reliance on natural gas, with very constrained diversity and capacity of import supply routes. This risk *may* become even more severe in the years immediately ahead as the only significant indigenous natural gas source (the Corrib gas field) is depleted and the other (even higher carbon intensity) fossil energy sources (coal, oil and peat) are progressively removed from the Irish energy mix. In July 2018, the Irish Academy of Engineering (IAE) published a major report assessing this evolving natural gas security-of-supply risk, entitled "Natural Gas — Essential for Ireland's Future Energy Security" (IAE 2018). The report argued that substantial continued reliance on natural gas in the overall Irish energy system is unavoidable up to at least 2040. On this basis, it recommended a number of major strategic interventions designed to manage the consequently deepening security-of-supply risk, i.e., measures attempting to assure continued access to natural gas.

In this response to that report[1], we present an independent peer evaluation of the basis for these recommendations. We base our analysis on the presumption that Ireland is committed to good faith action consistent with its ratification of the Paris Climate Agreement (UNFCCC 2015): specifically to play its equitable and commensurate part in holding the increase in the global average temperature to *well below* 2°C above pre-industrial levels and *pursuing efforts* to limit the temperature increase to 1.5°C. We assume the IAE shares this premise.

On this basis we find that the IAE analysis is mistaken both in its assessment of the required speed of decarbonisation of the Irish energy system (and therefore the need to rapidly phase out all fossil fuel emissions, *including* from natural gas), and in its discounting of the technical and economic feasibility of such rapid decarbonisation. On the contrary, given Ireland's large natural resource of variable renewable energy (especially wind), and coupling this with the use of synthetic chemical fuels ("electrofuels") for very large scale energy storage, we find that rapid fossil fuel phase out is not only technically feasible, but can progressively *eliminate* the security-of-supply risks associated with all imported fossil fuels, while *simultaneously* decarbonising with the scale and urgency demanded by good faith participation in the Paris agreement — subject, of course, to securing the comprehensive societal support necessary to enable this transformation.

While the electrofuel storage element of this pathway is challenging in terms of technology maturity and immediate investment cost, this is true of *all* decarbonsation pathways that might credibly be commensurate with meeting the Paris climate goals; but this pathway has the unique advantages of high confidence in the effectiveness of decarbonisation and relatively rapid achievement of very high national energy security. Such a rapid fossil fuel phase out would additionally bring very significant co-benefits in balance of payments and overall national social and economic resilience. These findings also decisively contradict the IAE suggestion that continued exploration for indigenous fossil fuels is in the national interest of Ireland.

[1] This response was commissioned as an expert peer review on behalf of Stop Climate Chaos (SCC), a coalition of Irish civil society organizations campaigning for effective climate action. The authors conducted the review independently and on a *pro bono* basis. All material affiliations of individual authors are disclosed in the author information at the end of the document. The content and findings of this review remain the sole responsibility of the authors.

Key Findings

- The IAE report severely underestimates the rate at which CO_2 emissions from the Irish energy system must now be eliminated — *assuming* good faith action on the basis of the Paris Climate Agreement. This fundamentally undermines the analysis presented.
- We *agree* fully with the IAE that reliance on imported natural gas already raises very serious security-of-supply concerns for the Irish energy system.
- However: any energy policy involving the displacement of other fossil fuels specifically in favour of natural gas, even on a "transitional" basis (a so-called "natural gas bridge"), as suggested by the IAE, would greatly *escalate* that security-of-supply risk while simultaneously *failing* to achieve the required speed of decarbonisation of the Irish energy system. This arises from relying — by design — on a single, high carbon, fuel (natural gas) for critical stability and inter-seasonal balancing of the electricity system, while tacitly assuming progressive electrification of significant proportions of current transport and heating energy demand. Given limited (and rapidly depleting) indigenous natural gas supply, this would introduce, *by design*, a potential single point of failure for almost the entire energy system in the case of any major international natural gas supply disruption, while simultaneously inhibiting the required scale and speed of energy system decarbonisation.
- In contrast, we argue that by far the best way to address both Irish energy security and the pressing need for rapid decarbonisation is to constrain and reduce energy consumption (through efficiency measures and/or absolute reductions in energy services) and to directly exit from the use of *all* fossil fuels, including natural gas, as quickly as is safely feasible, replacing them by indigenous zero- or (potentially) negative-carbon energy resources to the maximum possible extent.
- In the specific case of Ireland, there are clearly identifiable pathways to transition the great majority of its energy requirement to proven indigenous zero- or negative-carbon energy sources (primarily wind, solar, and sustainably cultivated indigenous bioenergy). This does require, inter alia, the development of large scale (multi-TWh) energy storage facilities to buffer variability on at least an annual basis. We find that such energy storage is technically feasible, using well proven conversion and storage technologies, through the use of gaseous and/or liquid "electrofuels": hydrogen, ammonia, possibly synthetic hydrocarbons (with carbon cycling), all produced primarily from indigenous variable renewable energy sources.
- Finally, within the known physical constraints of the Paris Climate Agreement (the "Global Carbon Budget") we find that there is no credible case to be made for bringing *new* fossil fuel resources into production: any such additional production would inevitably add to total global atmospheric concentration of CO_2. Short term, not to say fundamentally misplaced, concerns in relation to national energy security cannot ethically be addressed by compromising climate stability for generations to come (cf. Boyd 2018): therefore neither current energy security concerns, nor, especially, a deliberate choice to further impair future energy security (through a mistaken "gas bridge" decarbonisation strategy) can be taken as valid arguments against the immediate cessation of new Irish offshore fossil fuel exploration which has been proposed in the Petroleum and Other Minerals Development (Amendment) (Climate Emergency Measures) Bill 2018.

List of Abbreviations

AD: Anaerobic Digestion (for biogas/biomethane production)

BECCS: BioEnergy with Carbon Capture and Storage (potential "negative emissions" technology)

CCS: Carbon (CO_2) Capture and Storage

IAE: Irish Academy of Engineering

IEA: International Energy Agency

IPCC: Intergovernmental Panel on Climate Change

LNG: Liquified Natural Gas

NGCCS: Natural Gas with Carbon Capture and Storage

NORA: National Oil Reserves Agency (Ireland)

P2X: Power-to-X technologies, involving the conversion of surplus variable renewable electricity to any of a variety of other energy carriers (such as hydrogen, ammonia or hydrocarbon fuels, all generically denoted "X").

SDS: Sustainable Development Scenario (one of the scenarios presented in the annual World Energy Outlook of the International Energy Agency)

SEAI: Sustainable Energy Authority of Ireland

UNFCCC: United Nations Framework Convention on Climate Change

WEO: World Energy Outlook (published annually by the International Energy Agency)

Introduction

In July 2018, the Irish Academy of Engineering published a major report entitled "Natural Gas — Essential for Ireland's Future Energy Security (IAE 2018). This is a significant contribution to ongoing debate about the evolution of the Irish energy system, especially in the context of required, rapid, decarbonisation. The report contains much valuable information and insightful discussion. Nonetheless, we find that the substantive conclusions are fundamentally mistaken, and would be damaging and counter-productive if applied to Irish energy policy development. We set out here the detailed basis of our critique, and urge further constructive discussion on these critical and urgent issues, including proactive engagement with wider society. The decisions involved will profoundly affect the well-being of all Irish citizens, not just in the decades immediately ahead, but for centuries to follow.

Projecting Future Natural Gas Consumption in Ireland

The specific recommendations of the IAE report which we are concerned with are those in support of the development of import facilities for Liquified Natural Gas (LNG) and of continued exploration for fossil fuels (including, but not limited to, natural gas) in Irish offshore territory.

In the first instance, these recommendations hinge on the projection by the IAE of continued reliance on natural gas for Irish energy needs, a reliance that is anticipated to extend to at least 2050:

> "Based on an examination of long-term energy outlooks from the International Energy Agency and various other organizations, the Academy believes that *natural gas will continue to be a large part of the world's, Europe's and Ireland's energy mix until at least the middle of this century.*" (IAE 2018, emphasis added)

If that projection is accepted, then virtually everything else recommended by the report might arguably follow (albeit, against a background of escalating climate disruption and impacts, both locally and globally). Ireland would indeed be faced with severe concerns over the security of its access to natural gas over the next 30 years (and beyond), and the development of LNG facilities, and the continued support for offshore exploration would appear eminently sensible, if not absolutely essential, things to do.

But is this projection of sustained reliance on natural gas well grounded?

The IAE report provides only limited detail on the background basis of its projection. It explicitly cites the International Energy Agency's World Energy Outlook (WEO) 2017 (IEA 2017). Three WEO scenarios are referenced, ranging from "Current Policies" to the "Sustainable Development Scenario" (**SDS**). The latter is currently the most ambitious WEO scenario in terms of CO_2 mitigation, and is described by the IEA as being "fully aligned" with at least the 2°C temperature goal of the Paris Climate Agreement (UNFCCC 2015). The Academy of Engineering reports says that even under the decarbonisation objectives of SDS, "Gas consumption [globally] in 2040 would be 20% higher than today"; though it does then acknowledge that, for the EU specifically, SDS would require natural gas use to be "20% lower" (compared to 2016). But if we just apply that latter number to Ireland (as a "typical" EU state) that would still seem to imply large scale natural gas usage (~80% of current levels) at least to 2040, even in the case of such apparently "ambitious" climate mitigation.

So: where is our disagreement?

Firstly, the IEA itself has long recognised that natural gas is still a high carbon energy source, and its continued use would inevitably carry significant environmental risks. As far back as 2012, the IEA Chief Economist was quoted as saying that "[a] golden age for gas is not necessarily a golden age for the climate" (Harvey 2012) and, further, that "**[we] are not saying that [this] will be a golden age for humanity - we are saying it will be a golden age for gas**" (Nathanael 2012).

More particularly, while the IEA World Energy Outlook argues that the SDS is aligned with at least the 2°C Paris temperature goal, there is very significant contention around that claim. The current WEO scenarios formally only run to 2040, but in relation to the claim for SDS Paris alignment, the IEA explicitly acknowledge that:

> "Maintaining [the] rate of reduction of energy- and process-related emissions after 2040 [consistent with the Paris temperature goals] will require continued technological innovation, including for carbon capture, utilisation and storage (CCUS) and *so-called negative emissions technologies that allow for CO_2 to be withdrawn from the atmosphere at scale*." (emphasis added)

So, in effect, to adopt the IEA SDS scenario as a basis for policy *up to 2040* would automatically involve a tacit commitment to, and reliance upon, planetary scale deployment of negative emissions (CO_2 removal) technologies *after* 2040. This is not a minor qualification: it calls into question the entire foundation for the use of the scenario in *current* policy development — at least for any country which considers itself as a good faith party to the Paris Agreement. As summarised in the journal *Science*:

> "Negative-emission technologies are not an insurance policy, but rather an unjust and high-stakes gamble. There is a real risk they will be unable to deliver on the scale of their promise. If the emphasis on equity and risk aversion embodied in the Paris Agreement are to have traction, negative-emission technologies should not form the basis of the mitigation agenda. … [Rather] *the mitigation agenda should proceed on the premise that they will not work at scale*. The implications of failing to do otherwise are a moral hazard par excellence." (Anderson and Peters 2016 emphasis added)

Separately, there is a significant question mark over whether the IEA SDS analysis adequately represents the justice and equity aspects of the Paris agreement: in particular, whether that figure of just a 20% fall in EU natural gas consumption by 2040 would represent a "fair" share of mitigation effort by the EU relative to other less developed regions?

Both of these critiques of the IEA SDS are explained in further detail in a recent Oil Change International report, which concludes:

> "… By accepting a mere 50 percent probability of success [in meeting the 2°C limit], by assuming negative emissions technologies will be invented, and by assuming unrealistically low non-energy emissions, the SDS significantly understates the degree of change in energy systems needed to achieve the [Paris Agreement] goals." (Muttitt 2018)

It is worth noting that, coming toward the end of 2018, the current indications from the IEA itself are that global CO_2 emissions are continuing to *increase* (Simon 2018). So any scenario developed in the last few years (such as SDS) should properly be adjusted to meet today's reality and include

reasonable judgements on tomorrow's emissions. Based on the IPCC AR5 carbon budgets (IPCC 2014), we suggest that for energy-only from January 2019 there is only about 550 $GtCO_2$ of emissions "budget" remaining globally for a "likely" chance of limiting global temperature increase to 2°C (and this still relies on very optimistic assumptions about deforestation and process emissions across the century). Current annual (and growing) global CO_2 emissions from fossil energy use are ~37 $GtCO_2$/yr, representing less than 15 years remaining if the current pattern continues. Note that these figures are focussed on a 2°C threshold of global temperature increase, and predate the further analysis presented in the recent IPCC Special Report on Global Warming of 1.5°C (IPCC 2018). Meaningful near term action in support of the 1.5°C limit would, of course, have to be significantly more stringent even than for 2°C. In short, thinking about 2020 and beyond requires us to take account of what is happening now and very likely to occur over the coming few years. Given how small the remaining carbon budgets are for any prudent or even tolerable limit on global temperature rise, future emission space and appropriate technology pathways are highly sensitive to current and very near term CO_2 emissions.

To be clear: regardless of the detailed analysis, for the present purposes it is enough to say that there are very well founded disagreements with the IEA characterisation of the SDS as adequately aligned with the Paris Agreement goals. It was therefore properly up to the Academy of Engineering report both to acknowledge these differing perspectives, and articulate on what basis it then favours the SDS. In fact, the only critical assessment of the SDS offered by the IAE report is to refer to a specific comparison between projections from "many organisations" that was included in "BP's latest World Energy Outlook" and to state that "[a]ll outlooks show global energy demand continuing to grow over the next 20 to 30 years with [natural] gas growing faster than all other energy sources, apart from renewables." But the IAE report omits to say which (if any) of these "many" outlooks are actually compatible with the Paris temperature goals, and the Paris requirements for justice and equity. Absent that information, the relevance of this "comparison" would be moot at best.

While the IAE don't provide a precise reference here, it appears that they are relying on material from pages 114-117 of the full BP Energy Outlook 2018 document (BP 2018). The critical background provided there is:

> "There are many different published outlooks and it is not possible to do a comprehensive survey. To aid the comparison, where possible the external scenarios selected are based on assumptions for policy, technology and social preferences most similar to those underpinning the ET [BP Evolving Transition] scenario."

So, the baseline for *all* the scenarios in this comparison is the BP "Evolving Transition" scenario. The key, relevant, characteristics of this scenario are well captured in the refreshingly clear and candid commentary from Mr. Bob Dudley, BP Group Chief Executive, on page 5 of the same document:

> "The third, and most important, takeaway ... from this year's Outlook is the need for more downward pressure on carbon emissions. The Outlook's **Evolving Transition** scenario suggests that a continuation of the recent progress and momentum in policies and technologies is likely to cause the growth in carbon emissions to slow markedly relative to the past. But this slowing falls well short of the sharp drop in carbon emissions thought necessary to achieve the Paris climate goals. We need a far more decisive break from the past." (BP 2018)

Thus, the "many projections" cited by the IAE report as providing the fundamental basis for their entire subsequent analysis were explicitly selected for their similarity to a scenario that, by the testimony of BP's own Group Chief Executive, *"falls well short of the sharp drop in carbon emissions thought necessary to achieve the Paris climate goals"*.

There is therefore a clear difficulty with the IAE assessment of the trajectory of natural gas usage in Ireland over the coming decades, and considerable doubt over whether what the report has assumed is meaningfully consistent with the Paris Agreement. To the very limited extent that it addresses the Paris Agreement temperature limits at all, it considers only the 2°C goal; but even since the publication of the IAE report itself, this position has been superseded by the new IPCC Special Report on Global Warming of 1.5°C (IPCC 2018), which makes clear the critical implications and importance of taking action on the basis of that more stringent objective of the Paris Agreement. For all these reasons, recommendations based directly on the natural gas consumption projections adopted by the IAE cannot be regarded as sound.

Natural Gas as an Irreplaceable Backstop to Intermittent Renewable Electricity Generation?

The IAE report goes on to identify another different but complementary argument for a continued critical *reliance* on natural gas in the Irish energy system, specifically in electricity generation. This complementary argument might therefore still support the final recommendations, even if it were conceded that overall Irish energy system decarbonisation has to happen significantly faster than the report has envisaged.

The report essentially asserts that there are hard limits to how much of Ireland's energy needs can practically be serviced by intermittent renewable electricity. Specifically, it states (p. 7) that: "... [r]enewables will account for a growing share of Ireland's electricity supply in the next 20 to 30 years. Wind and solar generation are expected to provide up to a half of Ireland's annual electricity. Fossil fuels will be needed to generate the other half." Given both the essential enabling role of electricity in overall societal energy use, and the likelihood of significant further electrification of the currently largely non-electrified transport and heat energy sectors, this assertion that no more than ~50% of electricity generation can be met by intermittent renewable sources is then critically important. If that assertion is correct then that indeed leaves a gap of ~50% that has to be fulfilled in *some* other way. Further, unless that gap is filled, even access to dynamically available intermittent renewable generation could potentially be compromised due to challenges of stable system operation. Ireland has (pro tem) rejected the deployment of nuclear generation within its jurisdiction, and natural gas, although a very high carbon energy source, is still the least carbon intensive of the fossil fuel options. Thus, the IAE argument is that the bulk of that generation gap will *have* to be filled by natural gas. Such a reliance on natural gas in electricity generation, more or less to the exclusion of other fossil fuels, coupled with progressive electrification of heat and transport, would then make Ireland's overall energy security even more precarious than it is now.

The report does acknowledge that this "residual" (but indefinitely sustained?) reliance on natural gas would then pose a serious difficulty with the goal of achieving progressively deeper decarbonisation (whose *ultimate* necessity is not disputed). Once gas has displaced all other fossil fuels there would be no further "easy", lower intensity, substitute fuel available. The report suggests that this might be addressed through some combination of partial displacement of

natural (fossil) gas by "renewable gas" and the continued use of natural gas but with substantial emissions mitigation via carbon capture and storage (CCS) technology. We will consider each of these in turn.

While "renewable gas" is not precisely defined in the report, the discussion is focussed exclusively on indigenously produced biomethane and concludes that the contribution from this source, within the next two (critical) decades, will be very modest, at best:

> "Biogas from renewable sources has the potential to supply some of Ireland's gas needs. Gas Networks Ireland estimate that up to 20% of Ireland's gas demand could potentially be met from renewable [primarily biomethane?] sources. However, there are significant challenges to be overcome – planning and permitting, public acceptance, scale and costs of infrastructure needed, gas quality control etc. It is likely to take several decades to develop a large-scale renewable gas industry in Ireland. *In the Academy's view, renewable gas will account for only a small part of Ireland's gas supply by 2040.*" (emphasis added)

As an aside, it is important to note that the overall climate mitigation benefit of bioenergy relative to fossil fuel use is highly variable at best, and may even be non-existent for some specific production pathways (EEA-SC 2011). In the case of biomethane from anaerobic digestion (AD), the risk of methane leakage to atmosphere – itself an extremely potent greenhouse gas – means there is a requirement for extremely robust (and potentially costly) independent regulation and monitoring of production sites (Liebetrau et al. 2017). Separately, in considering AD pathways, it is essential to account fully for any additional use of nitrogen fertilizer – which would inevitably lead to increases emissions of N_2O, another potent and long-lived greenhouse gas. We would therefore agree with the Academy conclusion that bioenergy can be prudently relied upon only for a relatively small contribution to overall energy system decarbonisation (in Ireland and globally).

So we are left with the second option, continued large scale use of natural gas electricity generation, but with carbon capture and storage (NGCCS), as apparently being essential to achieving deep decarbonisation of electricity (and the wider energy system) in Ireland. In this case, based on the Academy's assessment, natural gas would still account for something like ~40-50% of Irish electricity use at least to 2040 (and, by extrapolation of asset lifetimes, would suggest continued significant natural gas usage well into the second half of the century). Penetration of natural gas in the energy system as a whole would depend on the degree of electrification of heating and transport, and the continued role of natural gas in the remaining non-electrified energy use; but overall penetration could hardly be much less that that indicated for electricity alone (assuming higher emission fossil fuels are already displaced in all uses). In such a scenario, Ireland would indeed be acutely exposed to disruption of natural gas supply (or, equivalently, to severe constraints on CO_2 emissions arising from mandatory international action — e.g., imposed at collective EU level). Any such disruption could fundamentally compromise the entire energy system. Indeed, absent other measures, even the intermittent renewable electricity elements might only operate provided that there is a significant, dispatchable, backstop, which, in this scenario, must come primarily or solely from natural gas power plants. In case of serious natural gas supply disruption there would be a real danger of losing almost *all* societal energy services (transport, heating, and all "conventional" electricity use).

The key point here is that, even if it is conceded that much faster decarbonisation is necessary, the logic of the IAE analysis is *still* that (absent nuclear power and with only limited bioenergy availability) Ireland would continue to require a very significant and critical role for fossil natural

gas. In this approach, the *only* substantive implication of faster decarbonisation would be that the deployment of CCS in natural gas electricity generation would have to be greatly accelerated (along with associated electrification of heating and transport to shift unabated fossil fuel consumption in those sectors to electricity instead). However, the *relative dependence on imported natural gas, and the energy security risk associated with that, would be just as severe, if not more so* — precisely because Ireland would be focusing down on natural gas, to the exclusion of other fossil fuels, even more quickly. *If* that is the scenario Ireland is necessarily navigating toward, then it would appear that the central IAE recommendations (LNG import, and continued promotion of indigenous fossil fuel exploration) all still follow.

Of course, quite aside from this continuing, and indeed intensifying, natural gas supply security issue, there would be other very significant problems with such a strategy for (rapid) decarbonisation: problems that the IAE recommendations (which deal only with supply security) do not consider or even acknowledge. Specifically, there is the 5-10% of CO_2 emissions that CCS may not feasibly capture, the energy penalty of CCS (therefore requiring more fuel combustion for given delivered electricity), and the significant challenge of upstream emissions associated with natural gas extraction, processing and transport, again including direct methane leakage to atmosphere (Gibon et al. 2017; Anderson and Broderick 2017). Separately, there is potentially very limited capacity for geological storage of CO_2 within the jurisdiction.

Some of these issues *might* be eased, to an extent, by further technology development. For example, the so-called Allam Cycle gas turbine technology may feasibly and efficiently allow almost 100% CO_2 capture of power station emissions in the specific case of natural gas electricity generation (Allam et al. 2017). Or, applying CCS to even the modest available biomethane supply might — arguably — yield some nett CO_2 removal from the atmosphere (Price et al. 2018) which could conceivably compensate for residual positive emissions from natural gas CCS. Similarly, if indigenous Irish CO_2 storage sites proved unsuitable or inadequate, CO_2 might be transported by ship for geo-storage in other jurisdictions (Skagestad et al. 2014); indeed, it has been reported that Norway has an active interest in delivering such internationally traded CO_2 storage services (Tannenberg 2017). But the timeframe for such developments (at relevant scale) is likely at least two to three decades, which is not aligned with the rate of decarbonisation now immediately required; and in any case, they would still not address all the specific challenges (such as continued "upstream" emissions of both CO_2 and methane) which such a natural gas CCS "decarbonisation backstop" pathway would present.

The IAE report does consider, but quickly dismisses, one other route to energy decarbonisation that *would* in principle allow the progressive elimination of more or less all fossil fuel use, even including natural gas, and thus also defuse the intensifying gas security challenge. This route is for a transition to a predominantly electrified energy system, primarily supplied by indigenous intermittent renewable resources (mainly wind), but with the addition of sufficient (dispatchable) energy storage to allow full compensation for both short-term (inter-hour, inter-day) and long-term (inter-season, inter-year) fluctuations in supply. Just two potential storage technologies are (briefly) considered: battery and pumped hydro. However, based on an assessment that neither of these can conceivably function at the required scale (an assessment which we would agree with), this section of the report then concludes: "The Academy does not believe that electricity storage is a realistic solution to the problem of intermittent renewable electricity supply… in the Academy's view Ireland will continue to depend on fossil fuels for electricity generation, especially natural gas, until at least the middle of this century."

So, to summarize this central argument of the IAE report, it appears to reduce to the following:

- There is "no alternative" to indefinite reliance on substantial (~40-50%) natural gas use in electricity generation (with or without CCS) because of the fundamental intermittency, specifically on inter-seasonal timescales, of the main indigenous renewable sources (primarily wind).
- This strategy can (somehow!) be reconciled with the rate of decarbonisation required to limit risk of climate disruption and impacts to "tolerable" levels (locally and globally) — even though this assumption is *prima facie* entirely inconsistent with the best available scientific assessments (IPCC 2014, 2018); or, alternatively, that local impacts in Ireland will be minimal, and Ireland will be somehow decoupled from widespread impacts elsewhere.
- But this comes at an (unavoidable?) price of deepening natural gas security-of-supply risk and *therefore:* all feasible measures must be taken to secure natural gas supply.

Our critique, in response, is then two fold:

- For the reasons already described, the implied natural gas CCS rapid decarbonisation "backstop" pathway is itself just as impractical, both technically and economically, as any of the options otherwise dismissed by the IAE (nuclear, bioenergy, variable renewables coupled with battery or pumped hydro energy storage); worse, it is highly uncertain in its climate mitigation effectiveness while committing either to deepening energy insecurity or high cost counter-measures (or both).
- There is, in fact, an alternative and feasible strategy, that *can* reliably address all the issues identified, *specifically including national energy security,* and also the need for rapid deep decarbonisation: this is firstly to to constrain and reduce energy consumption (through efficiency measures and/or absolute reductions in energy services), and secondly to shift the bulk of the (reduced) supply requirement to variable renewables coupled with large (multi-TWh) scale energy storage *based on one or more synthetic chemical fuels ("electrofuels") as the energy carrier* (so-called Power-to-X or P2X technologies). But the IAE report does not substantively consider the possible roles of either consumption constraint or the large scale use of electrofuel based storage (unless very obliquely through ambiguity in the use of the term "renewable gas").

The specific option for Irish energy supply based primarily on variable renewables, with a dispatchable storage backstop using large scale synthetic electrofuel (produced during periods when variable renewable supply exceeds demand), has, in fact, been already extensively modelled and evaluated (Connolly and Mathiesen 2014). That particular study argued that "... a 100% renewable energy system [for Ireland] can provide the same end-user energy demands as today's energy system and at the same price." That study envisages separate large scale storage of liquid and gaseous synthetic hydrocarbon fuels (respectively methanol and/or dimethyl ether/DME, and methane). This particular approach does raise detailed issues around carbon (re-)capture and recycling; but in fact, small scale, turnkey, closed-carbon-cycle energy storage has already been demonstrated (Goodall 2017). Alternatively, targeting of non-hydrocarbon electrofuels (avoiding any overhead of carbon recycling) is also feasible. Detailed (positive) assessment of hydrogen based storage systems is provided by, for example, (Steward et al. 2009; cH2ange 2018). The commissioning of the world's largest hydrogen storage facility has recently been announced in the US (Air Liquide 2017). This is currently supplied from a high-carbon H_2 pathway but nonetheless

fully demonstrates the technical and economic feasibility of such very large scale H_2 storage systems. Ammonia is another emerging non-hydrocarbon electrofuel candidate (Wang et al. 2017), with a pilot demonstrator already in commissioning (Evans 2018). Additionally, both hydrogen and ammonia based systems offer the possibility of early "drop in" end-use decarbonisation of significant transport and heating applications, with some round-trip efficiency gain, and without relying on prior end-use electrification (as they would not require or rely on carbon recapture/re-cycling at the point of use). It is of note, for example, that hydrogen fuel cell passenger trains have already entered commercial service, offering an additional pathway to rail decarbonisation that does not rely on line electrification (Agence France-Presse 2018). Similarly, a large scale deployment of fuel cell based heavy goods vehicles has recently been announced in Switzerland (Wiseman 2018). Quite aside from their specific suitability for heavy transport applications, deployment of hydrogen fuel cell vehicles may represent a beneficial diversification from exclusive reliance on full battery electric vehicles where rapid global scale-up may be specifically constrained by lithium and cobalt supplies (Andrews 2018). It is also significant that extensive elements of the existing Irish natural gas network could be re-purposed for hydrogen use, thus protecting against early stranding of this critical public asset through the decarbonisation transition.

Separately from these various approaches to electrofuel energy storage and end-use, there may also be a practical and economic role for large scale inter-seasonal thermal energy storage (e.g., Lund et al. 2014). Recent research strongly supports integration of electrofuels (P2X), battery electric transport and long-term thermal energy storage as offering the most cost effective routes to deep decarbonisation of energy systems in Europe, and especially so under conditions of relative geographical isolation/limited electricity interconnection such as typified by Ireland (Brown et al. 2018).

The technical and economic feasibility of inter-seasonal energy storage via *liquid* electrofuels is already fully demonstrated in Ireland by the holding of strategic stocks of liquid *fossil* fuels. NORA, the Irish National Oil Reserves Agency, maintains a strategic reserve, primarily within the island of Ireland, sufficient to supply current national demand for those fuels for at least 90 days. As noted in the IAE report itself, while Ireland does not currently operate any large scale facility for *gaseous* fuel storage, the Southwest Kinsale reservoir was previously used to provide natural gas storage with capacity equivalent to about 18 days' supply, and other countries in Western Europe operate gas storage facilities with an average capacity equivalent to 100 days' supply. While there would be, of course, detailed design differences between gas storage facilities according to the specific target fuel (hydrogen, ammonia, methane etc.) the general technical and economic feasibility of very large scale (inter-seasonal) gaseous fuel storage is not contested by the IAE.

This does highlight the one point of at least partial agreement with the IAE: of the report's three main recommendations (LNG import, offshore fossil fuel exploration, and large scale natural gas storage), large scale chemical fuel storage of some sort is clearly intrinsic to the scenarios outlined above.

In relation to indigenous energy *supply* potential, the Sustainable Energy Authority of Ireland (SEAI) has estimated availability of Irish wind energy alone (onshore plus offshore) as being at least 140 TWh/yr (SEAI 2011). The most recent (2016) figure for total primary energy requirement in Ireland is 168 TWhr/y, fulfilling final energy consumption of 136 TWh/y (SEAI 2017). Allowing for continuing technological improvements in wind generation, for additional supply from solar and bioenergy sources, and for significant available energy efficiency gains, there is clearly the potential for the great majority of Irish energy needs to be met from indigenous renewable energy sources.

We acknowledge that the inherent inertia represented by our existing energy infrastructure, and the need to maintain essential societal energy services during the decarbonisation transformation, will require *some* ongoing transitional combustion of natural gas (and other fossil fuels): and for that (limited) transitional use, there may be an argument to minimise the associated CO_2 by deploying CCS in carefully targeted cases. CCS can also usefully support immediate mitigation of critical non-energy CO_2 sources (such as cement manufacture), and in building expertise and capability for future CO_2 *removal* from atmosphere (the success of which should not be *relied* on in current policy, but can certainly be a target of prudential preparation and active development).

Much more detailed technical planning and design, and a programme of very significant capital investment (both public and private) will be required to realise the rapid transformation to a fully fossil-free energy system as outlined above; but this would be entirely consistent with known general conditions for optimal climate mitigation investment (Vogt-Schilb et al. 2018). As noted, and given the short time now available, significant *reductions* in some energy uses will likely also be an essential intervention until decarbonisation is substantially complete (Grubler et al. 2018). Significant investment is certainly implied by all conceivable energy system decarbonisation pathways that would now be at all commensurate with the climate change challenge, based on good faith action in accordance with the Paris Agreement.

One preliminary but useful upper bound on likely levelized costs of electricity (which reflects investment costs) in such decarbonised energy systems, across a range of European countries, has recently been published based specifically on hydrogen electrofuel as the storage energy carrier (Brown 2018). While significant, even this upper bound (estimated at c. €87/MWh by 2030, in Ireland) would still be well within the range of economic feasibility. Moreover, these costs must be compared to the substantial ongoing investment that conventional high carbon energy systems require anyway (including, for example, the specific interventions positively recommended by the IEA).

The key point is that even at the very highest estimates of practical energy system decarbonisation costs, this transformation will still be immeasurably cheaper than continued use of fossil energy, once climate “externalities” are accounted for. See, for example Steffen et al. (2018) for the existential scale of what is now at risk. Most importantly, precisely because the approach outlined here localises the great bulk of Irish energy supply to entirely indigenous, sustainable and renewable sources, it would, at one transformational stroke, decisively resolve the chronic energy supply insecurity that has dogged Ireland virtually since the foundation of the state. Finally, this transformation would of course carry with it the potential for significant additional economic co-benefits in terms of indigenous employment and favourable trade balance.

Conclusion

> "If a country brings any additional fossil fuel reserve into production, then in the absence of strong climate policies, we believe it is likely that this production would increase cumulative emissions in the long run. This increase would work against global efforts on climate change." (MacKay and Stone 2013)

Returning to the core point of the IAE report: it does provide an excellent presentation of the acute energy security risks that *would* attach to prolonged and progressively more concentrated reliance on natural gas as essentially Ireland's single dispatchable electricity source (as well as, currently, an essential component of meeting direct heat demand). But the report then fails to follow the logic of its own analysis. Its prescription is, in effect, to fatalistically *accept* that such dependence on natural gas is "inevitable", to fundamentally understate the climate change implications of such continued dependence, and then consider progressively more problematic ways to shore up security of natural gas supply (LNG, offshore exploration).

The alternative, of course, is to attack the (genuine) energy security problem at its source, and proactively identify ways of avoiding having natural gas (or any other imported, high carbon, energy source) play a central role in Ireland's overall energy system. And given that there are realistic, affordable, pathways of doing that, which are well understood, already proven at the technology level, in the process of scaling up, and much better aligned with commensurate climate action, we conclude that the report's specific recommendations for locking in continued reliance on natural gas are without satisfactory foundation. Instead, the IAE recommendations present steps effectively leading in quite the wrong direction, undermining precisely those alternatives that would genuinely address the challenges of *both* decarbonisation and energy security.

Of course, it may be suggested that the huge scale and speed of change envisaged in the early elimination of all fossil energy is simply "unrealistic", that wider society is not ready or willing to endorse it, and that, above all, we must not "allow the perfect to be the enemy of the good". In response we would contend that the truly "unrealistic" path now is the one that imagines consigning to young people of today the burden of severely compromised planetary support systems that have been critically, perhaps irreversibly, undermined by a (lack of) decisive action today (Hansen et al. 2017; Spratt et al. 2018). As the meteorologist and commentator Eric Holthaus has recently remarked: "A livable world achieved through incremental changes may have been possible in the 1980s, but it's a fantasy now" (Holthaus 2018). Forget the "perfect": our true challenge now is to prevent the (superficially) "good" being the enemy of the desperately *necessary*.

Finally, we must comment on the following brief (but nonetheless deeply significant) remark, which appears on page 24 of the IAE report:

> "Banning [fossil fuel] exploration in Ireland will not reduce Ireland's gas consumption or greenhouse gas emissions. On the contrary, it would result in more gas imports and less energy security. It would result in an increase in greenhouse gas emissions as the imported gas is likely to be transported over very large distances, as well as increasing Ireland's cost of imports."

This appears to be a tacit, but clearly critical, comment by the IAE on proposed legislation currently before the houses of the Oireachtas, namely the Petroleum and Other Minerals Development (Amendment) (Climate Emergency Measures) Bill 2018 (Oireachtas 2018). That Bill does, in effect, propose precisely such a ban on further fossil fuel exploration in the national territory (onshore or offshore).

While there is much more that could be said about this Bill, for the purposes of this particular discussion, we will just emphasise that the critique presented above fully addresses the specific points raised in this IAE report. That is, provided that rapid energy system decarbonisation is given the policy priority that is now absolutely essential (cf. McMullin 2018), then there is no contradiction whatever between that Bill and achieving *both* radical emissions reduction in the short term *and* profound energy security for generations to come. Combining these imperatives offers a genuinely *inspirational and attainable* vision for Ireland's energy future, and we have no hesitation in commending enactment of this Bill as soon as possible, as one key measure to catalyse this essential transformation.

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About the Authors

Professor Barry McMullin is a professional academic engineer, holding degrees of BE (Electrical Engineering, UCD, 1980), MEngSc (UCD, 1983), and PhD (Computer Science, UCD, 1993). He worked in the energy and manufacturing industries before joining the School of Electronic Engineering of DCU in 1987. He was appointed full Professor at DCU in 2014. He has served in diverse academic roles, including as Executive Dean of the Faculty of Engineering and Computing. His research has been primarily in the area of cross-disciplinary complex systems science. He has an extensive track record of scholarly publication and of successful project funding under national and international RD&D programmes. He is a member of Engineers Ireland, an associate member of the Institution of Engineering and Technology (IET), and serves on the Engineers Ireland Energy and Environment Committee. He is currently co-PI/PI of three advanced research projects addressing different aspects of deep decarbonisation of energy systems: I*E-NETs, Potential for Negative Emissions Technologies in Ireland* (EPA), *Heterogenous Energy Storage in Paris-Aligned Scenarios for the Irish Energy System* (SEAI) and *Society-wide Scenarios for Effective Climate Change Mitigation* (EPA). **Disclosures:** Prof. McMullin serves on a *pro bono* basis on the Climate Change Committee of An Taisce (the National Trust for Ireland) and is a member of Feasta (the Foundation for the Economics of Sustainability). Both An Taisce and Feasta are affiliated with the Irish Stop Climate Chaos coalition, on whose behalf this report was commissioned.

Paul Price is a researcher at Dublin City University currently working on the project *IE-NETS, Investigating the potential for negative emissions technologies in Ireland* (EPA). He holds a BSc. in Geology and an MSc. in Sustainable Development. He attended the UNFCCC Paris climate conference in 2015 as an accredited civil society observer, and is author of a book chapter, *Are we serious about limiting global warming? Confronting persistent climate policy failure in Ireland* (Price 2015). For 25 years Paul was a specialist structural frame carpenter conserving historic buildings and making new oak frames. **Disclosures:** Paul Price serves on a *pro bono* basis on the Climate Change Committee of An Taisce (the National Trust for Ireland) and has represented An Taisce on the policy committee of the Irish Stop Climate Chaos coalition, on whose behalf this report was commissioned.

Dr James Carton graduated with B.Eng. in Manufacturing Engineering from Dublin Institute of Technology in 2005 and obtained his PhD. from Dublin City University, graduating in 2011, focusing on the research, design and development of Hydrogen and Fuel Cell technology. In 2017 Dr Carton was appointed Assistant Professor in Sustainable Energy at the School of Mechanical and Manufacturing Engineering Dublin City University. Dr Carton is the foremost academic in Ireland with a deep sectoral network in hydrogen and energy storage technologies, using analysis techniques to develop a clear understanding of the potential opportunity and barriers for the deployment of clean renewable technologies. Dr Carton's research includes the development of advanced functional materials for regenerative fuel cells and electrolysers for hydrogen production from excess renewable electricity. Dr Carton is a member of the Future Energy Leaders programme of the World Energy Council (WEC) and is presently co-leader of the Climate Change Task Force, developing energy policy and strategies for industry and governments. **No applicable disclosures.**

Professor Kevin Anderson is chair of energy and climate change at the School of Mechanical, Aerospace and Civil Engineering (MACE) at the University of Manchester, and Chair of Climate Change Leadership at Uppsala University, Sweden. He is deputy director of the Tyndall Centre for Climate Change Research and a non-executive director of Greenstone Carbon Management. He is research active with recent publications in Science, Nature and Nature Geosciences. He engages widely across all tiers of government on issues ranging from shale gas, aviation and shipping to the role of climate modeling (IAMs), carbon budgets and 'negative emission technologies'. His analysis previously contributed to the framing of the UK's Climate Change Act and the development of national carbon budgets. Kevin has a decade's industrial experience, principally in the petrochemical industry. He is a chartered engineer and a fellow of the Institution of Mechanical Engineers. **No applicable disclosures.**

About Stop Climate Chaos

Stop Climate Chaos is a coalition of civil society organizations campaigning to ensure Ireland does its fair share to tackle the causes and consequences of climate change, in line with the best available scientific evidence and on a basis of global equity and solidarity. The following is the full list of organisations currently affiliated with Stop Climate Chaos:

> Afri,BirdWatch Ireland, Christian Aid Ireland, Comhlámh, Community Work Ireland, Concern Worldwide, Cultivate, Cyclist.ie, Dublin Friends of the Earth, Eco Congregation Ireland, ECO UNESCO,Feasta, Fossil Free TCD, Friends of the Earth, Good Energies Alliance Ireland, Self Help Africa, Jesuit Centre for Faith and Justice, Just Forests, Kimmage Development Studies Centre, Latin America Solidarity Centre (LASC), Liberia Solidarity Group, Methodist Church of Ireland – Council of Social Responsibility, Mountmellick Environmental Group (MEG), National Youth Council of Ireland, Oxfam Ireland, Peoples Climate Ireland, Presentation Ireland, Tearfund Ireland, Trócaire, An Taisce, VITA V.O.I.C.E., and Young Friends of the Earth.

www.stopclimatechaos.ie

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APPENDIX 2

A STRANDED ASSET?

THE FUTURE OF GAS NETWORKS IRELAND PIPELINE INFRASTRUCTURE

Ian Lumley

An Taisce – The National Trust for Ireland

Sheikh Yamani the former Saudi Oil minister memorably said that the Stone Age would not come to an end because people ran out of stone, in considering the future of oil.

The history of transport and energy over the last two centuries is one of progressive redundancy of technologies and infrastructural systems. Examples include the redundancy of horse drawn transport in favour of steam or motor engines, of gas lighting systems in favour of electric.

The future of the Gas Networks Ireland (GNI) development strategy needs independent scrutiny as to whether it can address:

The limit on future oil and gas consumption set by meeting Paris Agreement targets to stabilise global climate to as near as possible to 1.5 degrees over pre-industrial levels.

Requiring most known existing oil and gas (reserves) to be left in the ground known as *"Unburnable Carbon*".

The impact of directing State and general investment resources into continued fossil fuel exploration, and infrastructure to accommodate continued use in all sectors including heating and transport, is undermining the investment needed in the level of energy conservation and renewables needed to supersede fossil fuel.

The transboundary legal and cost exposure of Governments, Directors of oil and gas exploration companies, their professional advisors and consultants and regulatory bodies licensing increased fossil fuel exploration and exploitation from climate litigation

IMPACT OF CONTINUED EXPLORATION

Globally, fossil infrastructure companies whether privately owned, PLCs or State owned like Gas Networks Ireland ("**GNI**"), are promoting a continued level of fossil fuel extraction and consumption which if burned is incompatible with the level of decarbonisation required to stabilize global climate at or as near as possible to 1.5 degrees C as required by the Paris Agreement.

The extension of oil and gas exploration into new areas, and using problematic new technologies, extends from the Arctic wilderness to Central Africa. The 2010 Deepwater Horizon spill clearly highlights the risks involved in deep sea drilling. Oil and gas extraction in the Niger delta has a high carbon impact and is the cause of major local pollution. The increased level of extraction from Canadian Tar Sands is devastating in environmental impact and generates a much higher level of emissions than conventional wells. The Keystone XL pipeline proposal to link Alberta to the southern United States highlights the mounting conflict between the fossil fuel lobby and climate science. Fracking in the US has created new environmental risks and has significant additional climate impact through methane leakage during the extraction process. While Ireland has banned land-based fracking, the proposed development of a LNG terminal in the Shannon Estuary would allow US fracked gas to be injected into the GNI network.

THE RISE OF CLIMATE LITIGATION

There is growing litigation across the world against fossil fuel exploration and extraction companies and State regulatory bodies, of which the current Friends of the Irish Environment Climate Case against the adequacy of the National Mitigation Plan and the case against the Shannon LNG terminal in Ireland is part.

Oil and gas exploration and extraction companies and regulatory bodies which could include the Commission for Regulation of Utilities in Ireland are facing an increasing number of lawsuits in the future that aim to hold them responsible for the impacts of climate change. What the companies or regulators knew about their contributions to global warming will answer some key legal questions, including whether they have continued or issued licenses or consents for exploration extraction,increased consumption and use of fossil fuel, while knowing they would cause public harm. Liability also extends to State and public bodies granting licenses for oil and gas exploration, extraction, and continuing or increased consumption.

These issues now face all oil and gas exploration and extraction companies and regulatory bodies in Ireland. At the same time there is a growing momentum for institutional and pension fund divestment from fossil fuels, as fund managers may also be joined to legal action. .

New York joins a growing chorus of institutional investors that have committed to divest in full or part. Cities like Paris, Capetown, and San Francisco; pension funds like the California Public Employees' Retirement System; faith-based groups like the Church of England; philanthropies like the Rockefeller Family Fund; and universities like Oxford, Stanford, and Georgetown have mobilized to divest over $6 trillion in total assets from the fossil fuel industry.

New York City is also suing five oil majors—BP, Chevron, Conoco Phillips, Exxon, and Royal Dutch Shell—for their contributions to climate change and efforts to cover up scientific evidence of its reality

https://phys.org/news/2018-01-nyc-fossil-fuel-investmentshere.html

THE GLOBAL CARBON BUDGET

Rapid global warming and resulting climate change now taking place has a simple cause: Every addition of carbon dioxide (CO2) due to human causes traps a corresponding additional amount of solar energy in Earth's atmosphere and ocean. This warming due to the accumulation of CO2 is irreversible on human timescales – once emitted the CO2 levels remain raised. Therefore, limiting climate change will require substantial and sustained reductions of greenhouse gas emissions from now on. At some point net emissions will need to be zero to stop further warming. The agreed 2^{o}C limit to global warming (above pre-industrial temperatures) therefore requires an absolute limit on the nett carbon emissions that can ever be emitted globally. This remaining total amount of future CO2 emissions to limit warming to 2^{o}C is called the 'global carbon budget'.

Even such a small change in the Earth's average surface temperature can have profound changes on the climate, geography, and biosphere that are the basis for all life, and for modern society, including the supply of crops for food. During the last ice age the average global temperature was only about 5^{o}C colder than today, yet sea level was 120m (400ft) lower and many areas populated today were deep under ice. In the last 10,000 years, a very stable climate, due to very steady natural CO2 levels, enabled agricultural civilisation to emerge and to thrive.

The problem for modern human civilisation which depends on large scale burning of fossil fuels for energy, thereby releasing CO2, is that at current, increasing rates of annual emissions, the remaining less than 2^{o}C global carbon budget will be entirely exhausted within as little as 15 to 30 years. Moreover, there is enough carbon stored in proven reserves of peat, coal, oil and gas to result in extremely dangerous global warming of 6^{o}C or even more.

Due to greenhouse gases from fossil fuel burning, livestock agriculture and deforestation, about 1^{o}C of warming has occurred since industrialisation. Now though, due to rapidly rising CO2 – and also due to other greenhouse gases, especially methane – oceans and atmosphere are warming rapidly by accumulating very large amounts of additional solar energy. Continuing the current pathway of ever increasing emissions would mean that a rise of 4^{o}C is entirely possible by 2100. This is a very dangerous rate of warming, faster than any known rise, even faster than during geological extinction events. On this dangerous track, it is quite certain that within ninety years every part of the world will be entirely changed and will continue to change, with very serious negative consequences for human civilisation and for all ecosystems. The only certain way for humanity to limit dangerous climate risk is to limit emissions within the available carbon budget. This means rapid and major changes in consumption patterns and energy production are needed. To do this at least cost means starting very soon and proceeding very quickly. The biggest question for humanity is how to divide the less than 2^{o}C carbon budget equitably between nations and future generations. There is no doubt though, that the greatest responsibility to act for change, and act fast, lies with wealthy nations and institutions.

Arguments justifying the continued exploration for fossil gas as a "transition" are also unjustified. In 2018 Oil Change International, alongside 20 partners from around the world, released a new briefing on gas production in G20 countries and why fossil gas is NOT a bridge fuel.

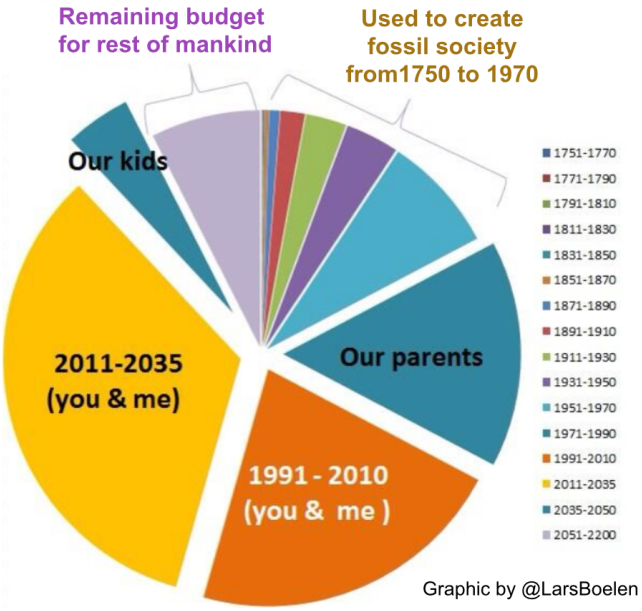


Figure 1 - Carbon Budget per Generation for 2°C: more than a third of emissions have been since 1970. The available remaining budget to limit warming to 2°C is being exhausted rapidly

THE SCIENTIFIC CASE FOR CEASING FOSSIL FUEL EXPLORATION

There is a convergence of research and reports by leading scientific authorities on the implication of allowing warming to exceed 2 degree Celsius, and the action needed in limiting burning of fossil fuel other climate impacts.

There is an extensive peer review literature on Unburnable Carbon by recognized independent scientists. A good overview is provided in the paper in NATURE-International Journal of Science on 17 Jan 2015 *" The geographical distribution of fossil fuels unused when limiting global warming to 2 °C* Christophe McGlade & Paul Ekins

> *"Policy makers have generally agreed that the average global temperature rise caused by greenhouse gas emissions should not exceed 2 °C above the average global temperature of pre-industrial times1. It has been estimated that to have at least a 50 per cent chance of keeping warming below 2 °C throughout the twenty-first century, the cumulative carbon emissions between 2011 and 2050 need to be limited to around 1,100 gigatonnes of carbon dioxide (Gt CO_2). However, the greenhouse gas emissions contained in present estimates of global fossil fuel reserves are around three times higher than this, and so the unabated use of all current fossil fuel reserves is incompatible with a warming limit of 2 °C. Here we use a single integrated assessment model that contains estimates of the quantities, locations and nature of the world's oil, gas and coal reserves and resources, and which is shown to be consistent with a wide variety of modelling approaches with different assumptions 5, to explore the implications of this emissions limit for fossil fuel production in different regions. Our results suggest that, globally, a third of oil reserves, half of gas reserves and over 80 per cent of current coal reserves should remain unused from 2010 to 2050 in order to meet the target of 2 °C.*

We show that development of resources in the Arctic and any increase in unconventional oil production are incommensurate with efforts to limit average global warming to 2 °C. Our results show that policy makers' instincts to exploit rapidly and completely their territorial fossil fuels are, in aggregate, inconsistent with their commitments to this temperature limit. Implementation of this policy commitment would also render unnecessary continued substantial expenditure on fossil fuel exploration, because any new discoveries could not lead to increased aggregate production."https://www.nature.com/articles/nature14016

Among the other most significant reports are the following:

Carbon Tracker Initiative and the Grantham Research Institute on Climate Change and the Environment (2013). ***Unburnable Carbon 2013: Wasted capital and stranded assets.*** **London: (Carbon Tracker & The Grantham Research Institute.**[1]

This assessed the consequence of burning existing total fossil fuel reserves against global atmosphere capacity to absorb the emissions generated if temperatures are not to exceed 2 degrees above pre-industrial levels.

It concluded that between 60-80% of coal, oil and gas reserves of publicly listed companies are unburnable if the world is to have any realistic chance of not exceeding global warming of 2 degrees Celsius. Conversely, if there is effective societal action to limit the extent of climate change, then this will raise the spectre of fossil fuel installations and distribution networks collapsing in value, with the global economy already facing 'the prospect of assets becoming stranded, with the problem only likely to get worse if current investment trends continue - in effect, a 'carbon bubble'.

The World Bank & Potsdam Institute for Climate Impact Research and Climate Analytics (2012). ***Turn Down the Heat: Why a 4°C Warmer World Must be Avoided, The World Bank 2012.*** **Washington: The World Bank.**[2]

This report assesses the scientific data on the implications of allowing emissions to exceed a 2 degree threshold. The abstract for the report states:

'This report focuses on the risks of climate change to development in Sub-Saharan Africa, South East Asia and South Asia. Building on the 2012 report, Turn Down the Heat: Why a 4°C Warmer World Must be Avoided, this new scientific analysis examines the likely impacts of present day, 2°C and 4°C warming on agricultural production, water resources, and coastal vulnerability for affected populations. It finds many significant climate and development impacts are already being felt in some regions, and in some cases multiple threats of increasing extreme heat waves, sea level rise, more

[1] http://www.carbontracker.org/wp-content/uploads/2014/09/Unburnable-Carbon-2-Web-Version.pdf
[2] http://documents.worldbank.org/curated/en/2012/11/17097815/turn-down-heat-4%C2%B0c-warmer-world-must-avoided

severe storms, droughts and floods are expected to have further severe negative implications for the poorest. Climate related extreme events could push households below the poverty trap threshold. High temperature extremes appear likely to affect yields of rice, wheat, maize and other important crops, adversely affecting food security. Promoting economic growth and the eradication of poverty and inequality will thus be an increasingly challenging task under future climate change. Immediate steps are needed to help countries adapt to the risks already locked in at current levels of 0.8°C warming, but with ambitious global action to drastically reduce greenhouse gas emissions, many of the worst projected climate impacts could still be avoided by holding warming below 2°C'

Price Waterhouse Cooper (2014). *Two degrees of separation: ambition and reality Low Carbon Economy Index 2014*. London: Price Waterhouse Cooper.

The 6th Annual index published by PWC shows the mounting failure in global action on decarbonisation to meet the 2 degree target:

> *'The 2014 Low Carbon Economy Index (LCEI) shows an unmistakable trend. For the sixth year running, the global economy has missed the decarbonisation target needed to limit global warming to 2˚C. Confronted with the challenge in 2013 of decarbonising at 6% a year, we managed only 1.2%. To avoid two degrees of warming, the global economy now needs to decarbonise at 6.2% a year, more than five times faster than the current rate, every year from now till 2100. On our current burn rate we blow our carbon budget by 2034, sixty six years ahead of schedule. This trajectory, based on IPCC data, takes us to four degrees of warming by the end of the century'*

Christophe McGlade & Paul Ekins. (2015). The geographical distribution of fossil fuels unused when limiting global warming to 2°C. *Nature*. 517 (187–190).

In January 2015 the international scientific journal Nature published a major paper on the level of fossil fuel burning compatible with maintaining a stable climate:

> *'If global warming is to be limited in this century to the much-publicized 2°C rise compared to pre-industrial levels, fossil fuel use and the associated release of greenhouse gases will need to be severely limited. This raises questions regarding the specific quantities and locations of oil, gas and coal that can be safely exploited. Christophe McGlade and Paul Ekins use an integrated assessment model to explore the implications of the 2°C warming limit for different regions' fossil fuel production. They find that, globally, a third of oil reserves, half of gas reserves and over 80% of current coal reserves should remain unused during the next 40 years in order to meet the 2°C target and that the development of resources in the Arctic and any increase in unconventional oil production are incompatible with efforts to limit climate change'*

CONCLUSIONS

Ireland has taken international leadership in the divestment of the State investment fund, where the Fossil Fuel Divestment Bill has passed second stage in the Dail. The leadership can now be followed by the cessation of issue of any further licences for hydrocarbon exploration or fossil fuel infrastructure whether on land or in the marine area.