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Irish Offshore Operators' Association

CLIMATE CHANGE RESEARCH PAPER

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Introduction and Background

The Earth's climate is a complex and dynamic system, involving constant change at varying rates, resulting from multiple control factors. There is clear scientific evidence of periods of times in the geological past when the Earth's global temperature was lower than present levels resulting in extensive ice cover, while at other times temperatures and greenhouse gas (GHG) levels were elevated and global sea levels were more than 100 m higher than present levels, due largely to the effects of melting glaciers and ice sheets[1]. In particular, global temperatures have fluctuated episodically and significantly over the past 800,000 years, and levels of atmospheric CO_2 levels have tracked the temperature changes (Fig. 1). There is clear scientific evidence that the rate of climate change in recent decades has increased and that anthropogenic factors (resulting from human activities) are accelerating such changes.

There is no universally-accepted definition for Earth's average temperature; different research groups and institutions (e.g., NASA Goddard Institute for Space Studies, NOAA National Climatic Data Centre, UK Met Office Hadley Centre) use different methods for tracking the global average over time. In most months of the year coherent areas of above and below average temperature can be identified. These data can be used to calculate the global average temperature anomaly. The data from all months of the year are combined to give a time series that shows how global average temperature has changed over time. Although many of the features of the time series are very similar, the global average temperature calculated from the main institutions are not exactly the same owing to the differences in the methodologies used. However, the trends from year to year and decade to decade are remarkably similar. Hence global change is very often described in terms of anomalies (variations above and below the average for a baseline set of years) rather than in absolute temperature. In particular globally-averaged temperatures in 2006 were almost 1° warmer than the mid-20th century mean (Fig. 2) and CO_2 levels have increased rapidly in the past century, reaching levels of almost 407 ppm in 2017 (Fig. 1).

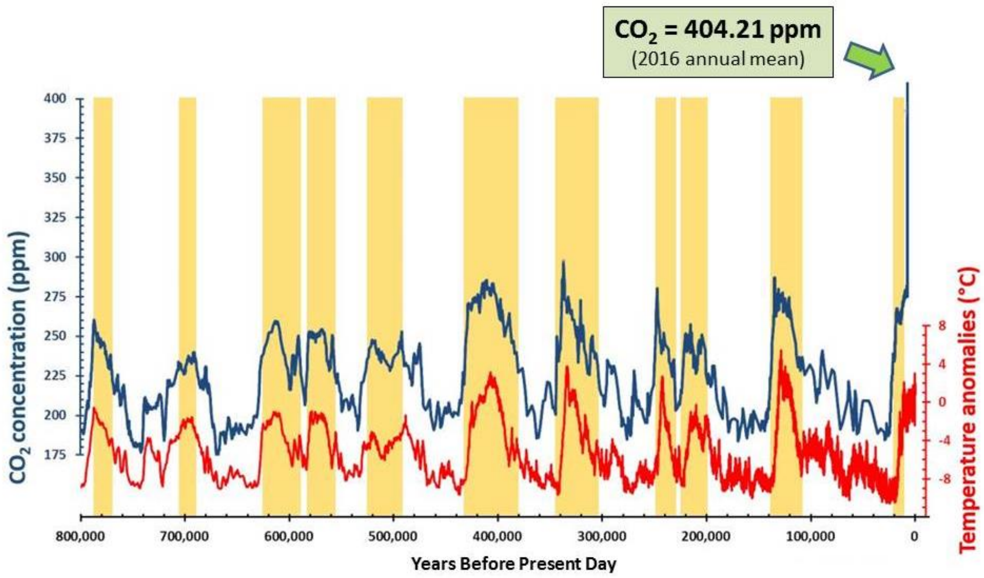

Fig. 1. Temperature anomalies (red) and CO_2 concentrations (blue) over the past 800,000 years. The areas shaded yellow represent warm interglacial periods while the uncoloured intervening areas represent colder glacial periods. Source: modified from B. Magi[2].

[1] http://www.bgs.ac.uk/discoveringGeology/climateChange/general/coastal.html

[2] http://clas-pages.uncc.edu/mesas/2015/01/14/climate-change-and-400-ppm-carbon-dioxide/

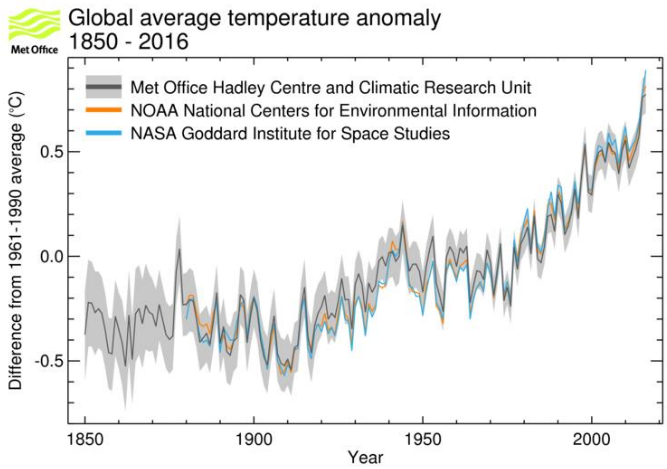

Fig. 2. Global average temperature anomaly showing that the globally-averaged temperatures in 2016 were almost 1°C warmer than the mid-20th century mean. Source: Met Office[3]

There is virtually unanimous agreement among nations of the need for action on climate change. In response to the increased global awareness and concern, the United Nations Paris Agreement on climate change, which came into force on 4th November 2016, seeks to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels by managing climate and environmental pressures while ensuring economic development[4]. Ireland formally signed up to the agreement in 2016. The growth in global population, combined with increasing industrialisation and development of large parts of the globe (e.g., India, China), will make the goals of the Paris Agreement extremely challenging to meet. Global development poses challenges to meet the food, water and energy needs of increasing populations. Energy, agricultural and industrial demands will all increase, with resultant climate stresses, unless unprecedented and co-ordinated action is taken to reverse global behaviour in areas ranging from energy use and agricultural practices to industrial development.

A major cause of accelerated climate change is the emission of greenhouse gases (GHG) and other aerosols[5]. These include carbon dioxide, methane and hydrofluorocarbons (HFC). These come from a variety of sources, most of which are anthropogenic, with two major sources being energy and food production. This document focusses primarily on the energy sector, and examines ways in which the energy sector, and particularly the oil and gas industry, can help provide solutions that will assist in achieving the objectives of the Paris Agreement. It reviews the international energy context and identifies potential impacts of energy transformation. It examines the Irish context, identifying key areas of concern and potential ways in which Ireland can achieve its commitments in transforming to a low carbon economy as well as providing an example to other countries of how to achieve a balanced and equitable transition.

International Energy Context

Energy is a key element in the climate challenge. Energy outlooks[6,7] point to a continued increase in energy demand, due to the growing global population and the increasing

[3] http://www.metoffice.gov.uk/hadobs/hadcrut3/diagnostics/comparison.html

[4] http://unfccc.int/paris_agreement/items/9485.php

[5] http://www.ipcc.ch/report/ar5/syr/

[6] World Energy Outlook 2016. International Energy Agency. http://www.iea.org/Textbase/npsum/WEO2016SUM.pdf

advancement and prosperity of large parts of the globe (e.g. India, China). The latest IEA energy projections[6] suggest global energy demand will increase to 2040 in all scenarios (including the 2°C scenario of the Paris Agreement) by between 9% and 43%. Other projections are broadly in line with this[7], suggesting a 30% rise in global energy demand within the next 20 years, largely attributed to growth in Asian prosperity. Such forecasts and scenarios should be used to better understand current uncertainties and plan a range of actions in line with those uncertainties.

A challenging transformation of the global energy system is clearly necessary in the medium-term. The future will require almost double the current amount of energy to meet the needs of a developing and growing global population, while reducing GHG emissions significantly in order to meet the targets of the Paris Agreement. Many of the renewable energy forms are currently at an early stage of development, and some are inherently intermittent, and therefore need to be supplemented by more reliable energy forms such as gas. Currently, renewables in power generation account for 3.2% of primary global consumption[8] (Fig. 3) and is the fastest growing source of energy (7.1% per annum). However, even assuming such sustained growth in the coming decades, its share in primary energy is only likely to reach 10% globally by 2035. This will be insufficient to match the predicted energy growth (30% to 2040), let alone replace existing energy sources. Therefore there is a requirement for a combination of the replacement of high GHG-emitting fossil fuels with a range of renewable energy forms, including solar, wind, geothermal and biomass energy, and also, in all probability, an increasing contribution of nuclear energy (e.g., France, with ~75% of its electricity generated from nuclear energy could recently announce a policy of transitioning rapidly from fossil fuels), together with the deployment of technologies to capture GHG emissions on a large scale to enable the continued use of cleaner forms of fossil fuels over a considerable transition period.

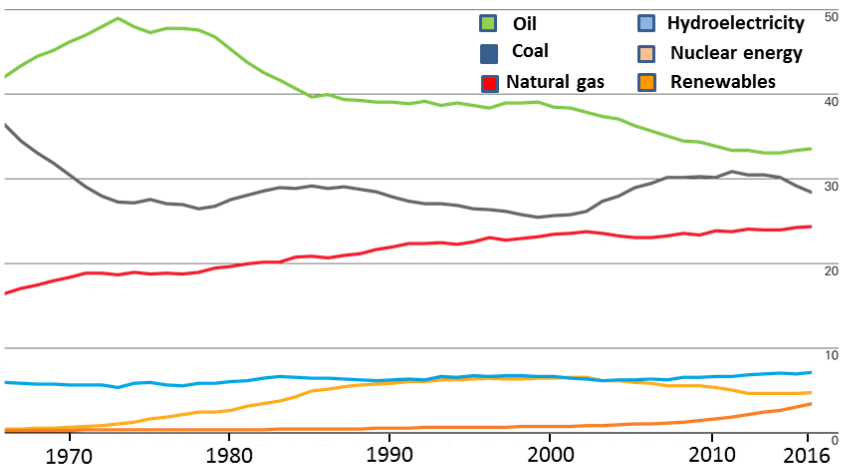

Fig. 3. Oil, coal and gas are the three major sources of global primary energy, currently comprising a total of 85.5% of global energy consumption in 2016, while renewables comprise 3.2% of the total[8].

The pathways to a low-emissions future require international action on three linked elements:

- Significant policy action,
- Technology development and deployment, and
- Business response.

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[7] BP Energy Outlook. 2017. https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2017/bp-energy-outlook-2017.pdf

[8] BP Statistical Review of World Energy 2017. http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

These three elements must be addressed at both global and national levels in order to ensure the best possible chance of success in addressing the climate challenge and meeting the objectives of the Paris Agreement.

The price tag for such a transformation is vast[9]. Investing US$120 trillion in energy projects between 2016 and 2050, at twice the current $1.8 trillion per annum is estimated[9] to have a 66% chance of achieving the Paris targets.

The International Oil & Gas Industry Response

For more than a century the oil and gas industry has met the majority of the world's energy demands and needs through oil and increasingly gas. The industry is constantly evolving to respond to global needs and energy challenges. Through research at the highest level, it continues to be a key leader and driver in providing much of the current understanding on Earth's dynamic processes, from plate tectonics, sedimentary systems and subsurface fluid flow to surface and oceanographic processes. It has developed key technologies for drilling, production and refining and has the potential to play a critical role, through innovative technological and product development, in achieving the low-carbon transition. The oil and gas industry has the skills, capabilities and resources to help transform energy systems.

The major companies in the oil and gas industry publicly acknowledge the significance of climate change, along with the urgent need for action in the transition to a low energy economy. Most companies have a public climate change policy statement outlining their vision and actions. These demonstrate a consensus that the oil and gas industry:

- Recognises that human-induced climate change is happening, and that action to limit the increase in the global average temperature to well below 2°C above pre-industrial levels is critical.
- Wishes to be play a role in tackling climate change while continuing to provide safe, cleaner, affordable and reliable energy whilst reducing emissions. The key challenge is to provide more energy with lower emissions.
- Believes that hydrocarbons will continue to be vital in meeting the world's energy needs, and that natural gas, in particular, will play an increasingly important role globally both in the energy mix and in reducing greenhouse gas emissions.
- Is taking action by reducing greenhouse gas emissions in its operations, helping consumers reduce their emissions, supporting research likely to lead to technology breakthroughs, and participating in constructive dialogue on national and international energy policy options.
- Considers that both global and national policies are required, involving a range of technologies such as CCS, and fiscal tools such as government-led carbon pricing mechanisms.

The coincidence of the Paris Agreement, a lower for longer price environment and accelerating electrification and digitalization of traditional markets has provoked industry to rapidly evolve development strategies. Many companies are positioning away from being simply oil and gas producers to become integrated energy companies, with many increasingly investing in renewable energy technology and power and gas markets. For example, 10 of the largest oil and gas companies (including a number of IOOA member companies), working through the Oil and Gas Climate Initiative (OGCI), announced in late 2016 the investment of $1 billion over the next 10 years to development and accelerate the commercial deployment of innovative low emissions technologies[10]. OGCI aims to deploy

[9] Goldthau, A. 2017. The G20 must govern the shift to low-carbon energy. Nature, *504,* 203-205.

[10] http://www.oilandgasclimateinitiative.com/news/announcing-ogci-climate-investments

successfully-developed new technologies among member companies and beyond. It will also identify ways to cut the energy intensity of both transport and industry. This demonstrates international leadership and a collective determination to deliver technology on a large-scale that will create a step change in tackling the climate challenge and in reducing the emissions of greenhouse gases, while continuing to providing the energy the world needs. OGCI's initial focus will be on accelerating the deployment of carbon capture, storage and use (CCS and CCU), and on reducing methane emissions from the global oil and gas industry in order to maximize the climate benefits of natural gas. The OGCI believes that these are areas where collaborative work of the oil and gas industry can have the greatest impact.

Global Impacts: Winners and Losers
There are significant economic opportunities in the development of solar, wind, wave, geothermal and storage technologies, many of which are at an embryonic or early stage of development or deployment. Countries developing and deploying these at scale are the obvious winners. In particular, OECD countries and China, the leaders in such technology development, will likely continue to achieve the economic benefits from both innovation and the application of the developing technologies into various sectors such as transport. However, there are also economic risks. Non-OECD and developing countries will, without international support, be unable to access new technologies to the same extent as more developed countries, and also the capital funds necessary to deploy the new technologies at scale.

Countries whose economies rely primarily on exporting fossil fuels will face increasing difficulties in selling their economic asset, while the resulting decrease in the asset value will mean that these countries will face increasing difficulties in obtaining financial resources to develop alternative industries. Such 'stranded assets' will increasingly result in 'stranded nations' if the transition is not managed in a coherent and planned manner. While some energy-rich countries have started to broaden and diversity their economic bases away from fossil fuel financial economies, other countries are less well advanced in the transformation and a rapid low carbon transition could result in economic hardship and domestic unrest[9].

Global Leadership Necessity
The low carbon transition requires leadership at both local and especially at global levels[9]. On a global scale there is a requirement for:

- Credible global leadership representative of the spectrum of developed, developing, resource-rich and resource-poor nations.
- Mechanisms to share information on climate-related technologies and investment risk and opportunities.
- Partnerships between technology leaders and those requiring assistance in the development and deployment of low-carbon technologies.

The G20, with expertise in all three of these areas, is well placed to play a key role in this area of global governance[9].

International Action Needed
Nations collectively need to reduce sharply the global atmospheric emissions of GHG and absorbing aerosols, with the goal of holding atmospheric levels at their lowest practicable value. An accelerated global transfer from high-carbon emission to low-carbon emission sources can make a significant impact on emission levels. The G20 Leaders' Communique

of September 2016[11], issued at its meeting in Hangzhou, China stated: "*Given that natural gas is a less emission-intensive fossil fuel, we will enhance collaboration on solutions that promote natural gas extraction, transportation, and processing in a manner that minimizes environmental impacts. We stress the importance of energy sources and routes*".

To reach the ambitious goals of the Paris Agreement, appropriate financial flows and a new technology framework are needed to support capacity building in developing countries.

National and scientific leaders of all nations need to recognize the substantial benefits to the overall well-being and economic progress, both nationally and globally, that will accrue through advancing the scientific understanding of, and the capabilities for predicting potentially disruptive environmental consequences and extremes. Industries and government organizations need to provide sound information on the regional and country specific impacts. Scientists need to communicate freely and widely with public and private decision-makers about the consequences and risks of on-going climate change and actions that can be taken to limit climate change and promote adaptation[12].

Key Technologies and Economic Enablers

The oil and gas industry will be an essential partner in the transformation of the energy system, and in particular in developing new technologies. Key industry efforts include:

- Reducing emissions,
- Helping consumers reduce emissions,
- Increasing use of gas to substitute for higher carbon energy forms,
- Developing alternative energy forms at scale,
- Developing and deploying Carbon Capture and Storage (CCS) and Carbon Capture and Utilisation (CCU), and
- Engaging on climate policy initiatives.

CCS/CCU is likely to be a key enabler of the continued use of oil and gas as a transition energy source while minimizing CO_2 emissions and either utilising them in the manufacture of fuels, carbonates, polymers and chemicals (Fig. 4), or safely and permanently storing the captured emissions ideally in the subsurface in a range of geological settings (Fig. 5)[13]. Most of the major scenarios for energy use and sources, and the resulting emissions projections, suggest a potentially important role for CCS[13]. In particular, the 2013 policy report of EASAC – the European Academies Science Advisory Council – concludes that CCS has the potential to make an important contribution to Europe's efforts to substantially decarbonise its electricity system and to achieve targets of greenhouse gas reduction[14].

[11] G20 Leaders' Communique Hangzhou Summit. Hangzhou, 5 September 2016 http://europa.eu/rapid/press-release_STATEMENT-.16-2967_en.htm

[12] http://www.iugg.org/resolutions/IUGGstatement_ParisAgreement_USA_12Jun2017.pdf

[13] Metz, B., Davidson, O., de Coninck, H., Loos, M. and Meyer, L. (eds). 2005. IPCC Special Report on Carbon Dioxide Capture and Storage. Cambridge University Press. 431 pp. https://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf

[14] http://www.easac.eu/fileadmin/Reports/Easac_13_CCS_Web_Complete.pdf

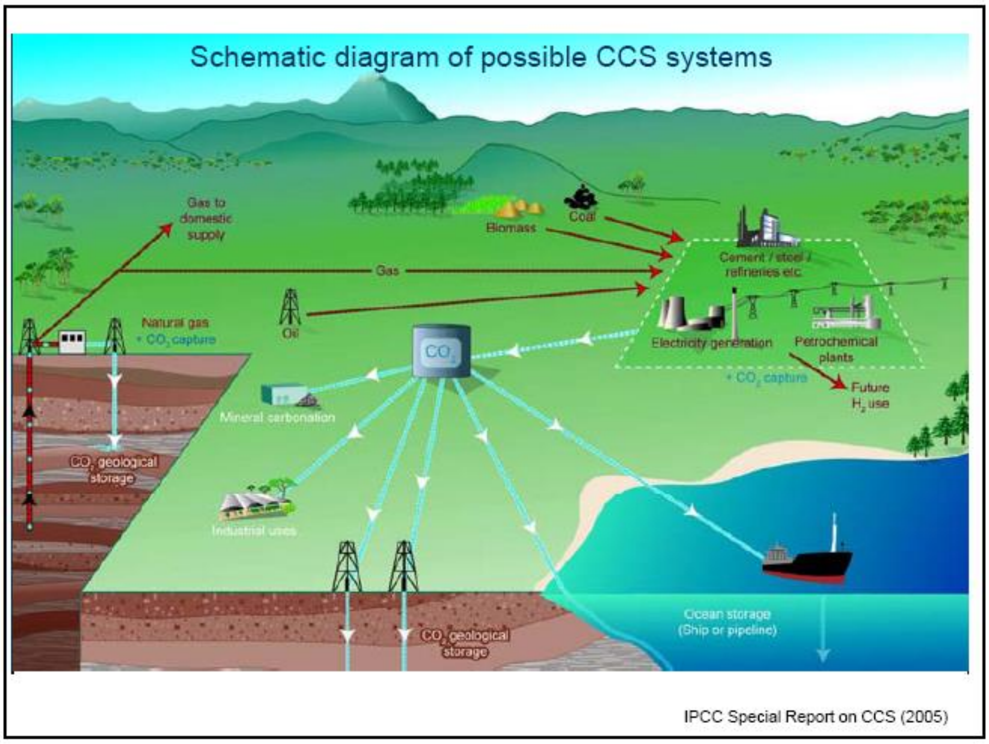

Fig. 4. Schematic diagram showing a range of possible carbon capture and storage/utilisation systems[13]

The Sleipner CO_2 storage industrial-scale demonstration CCS project, running since 1996, has been sequestering approximately 1 million tons of CO_2 each year into deep saline aquifers adjacent to the Sleipner gasfield in the Norwegian offshore[15]. Intensive monitoring (including eight repeated 3D time-lapse seismic surveys during the past 20 years) of the movement and behaviour of the sequestered CO_2 shows no evidence of any leakage. There are also other similar demonstration projects with equally promising results (e.g., the Weyburn Project in Saskatchewan, Canada[16]. Many of these demonstrate the potential of utilising depleted oil and gas fields to permanently and safely store CO_2. Despite technical and economic challenges, a number of new commercial-scale CCS demonstration projects are anticipated to start in the near future, most notably the Gorgon CO_2 Injection Project[17] in Western Australia (due to commence later in 2017) where up to 4 million tonnes of CO_2 per annum are planned to the stored in a subsurface aquifer.

CCU is a linked concept, currently the focus of research, whereby captured CO_2 emissions are utilised, typically through chemical processes, to react with minerals in specific types of geological formations, or with other products, to form new, stable and useful products such as aggregates. In essence, these are accelerating naturally occurring chemical processes to form the required products.

[15] https://unfccc.int/files/bodies/awg/application/pdf/04_sleipner-statoil_olav_skalmeraas.pdf

[16] https://ptrc.ca/+pub/document/Summary_Report_2000_2004.pdf

[17] https://www.chevronaustralia.com/docs/default-source/default-document-library/fact-sheet-gorgon-co2-injection-project.pdf?sfvrsn=16

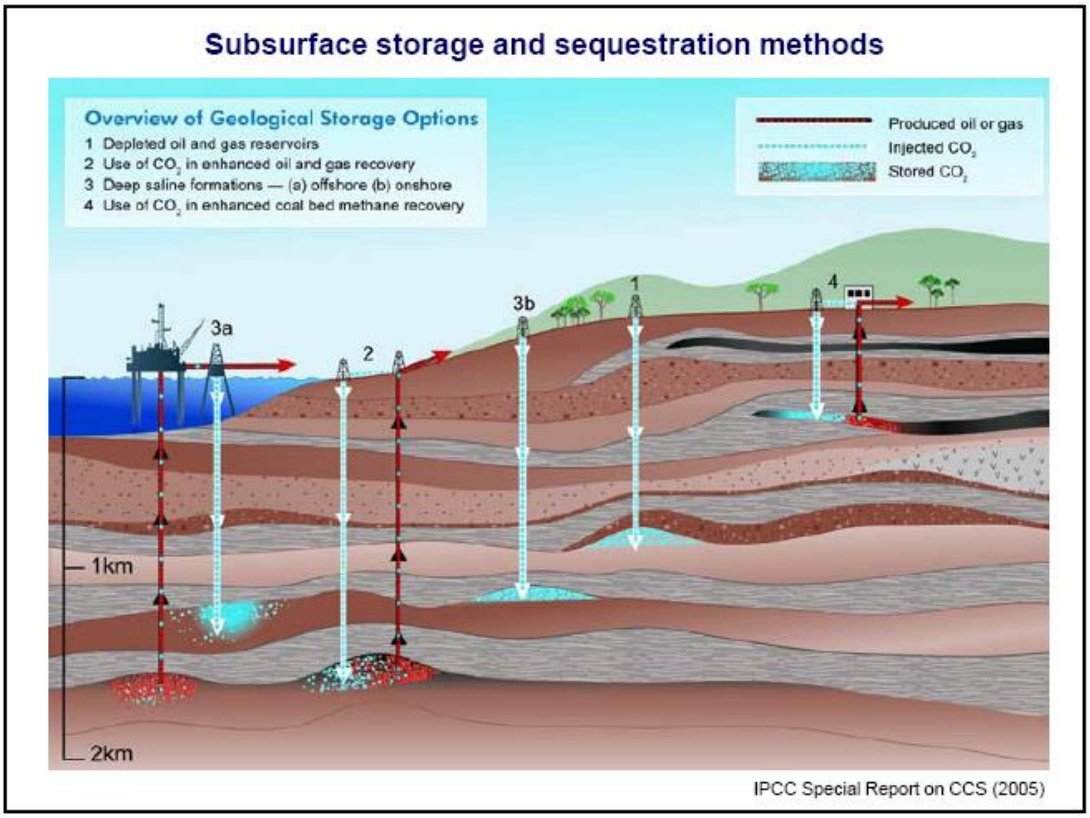

Fig. 5. Schematic diagram showing a range of possible geological subsurface CO_2 storage (CCS) systems[13]

CCS will likely be a key technology for transformation of the energy system. Already proven at scale, the key inhibitor with CCS is economic rather than technical. Appropriate policies are required to incentivise and stimulate CCS. Currently, the commerciality of large-scale CCS projects is challenging. However, establishing an effective global carbon pricing scheme would help focus attention on the cost of emissions and encourage CCS and other mitigation initiatives, thereby offering business opportunities as well as helping in the quest to mitigate the emissions.

While there is a lot of attention on CO_2 and methane emissions, attention should also be paid to other increasingly worrying greenhouse gases such as Hydrofluorocarbons (HFCs). These are ozone-friendly replacements for CFCs used as refrigerants but are powerful greenhouse gases and their use is rising rapidly (7% per annum). By 2050 global HFC emissions could reach the equivalent of 8.8 billion tonnes of CO_2, almost equivalent to the combined current carbon emissions of the USA and the EU. The results of recent research[18] suggest that aggressively regulating HFCs could reduce global warming by an estimated 0.5°C.

[18] A breath of fresh air. Editorial, Nature, 2015, *527,* p.133.

Ireland's Climate Change Challenge
While Ireland's direct impact on global climate is very minor (producing ~1.4% of EU emissions[19] and ~0.1% of global emissions[20]), IOOA believes that Ireland can, and should, take a lead in setting an example of how to tackle climate change. This can be achieved by planning and effecting an orderly and balanced transition in the timeframe to 2050[21] to a low carbon economy while maintaining the competitiveness of Irish industry and protecting the wellbeing of the people of Ireland. In this regard, all sectors in the Irish economy must play a major role in mitigating greenhouse gas emissions.

The published National Mitigation Plan[22] addresses four major areas of (a) Decarbonising Electricity Generation, (b) Decarbonising the Built Environment, (c) Decarbonising Transport and (d) An approach to Carbon Neutrality for Agriculture, Forest and Land Use Sectors. A greater use of natural gas substituting for other higher carbon energy forms (e.g., coal, peat and oil) in electricity generation will clearly impact on electricity generation and on a number of areas in the transport sector. However, a number of major areas in the transport sector will remain challenging, as currently there is no substitute to oil and oil products in the aviation or shipping industry in the foreseeable future. A short or medium term elimination of fossil fuels (especially oil and gas) in these areas is therefore unrealistic.

Emissions in Ireland
The Paris Agreement aims to tackle 95% of global emissions through Nationally Determined Contributions (NDCs) which will increase in ambition over time. Ireland's contribution to the Paris Agreement will be via the NDC tabled by the EU on behalf of its Member States. This targets an overall EU reduction of at least 40% in greenhouse gas emissions by 2030 compared to 1990 levels. The target will be delivered collectively by the EU with a 43% reduction in the Emissions Trading Scheme (ETS) and a 30% reduction in non-ETS sectors compared to 2005 levels (National Mitigation Plan).

<u>ETS</u>
The 2009 Emissions Trading Directive established a cap and trade system for GHG emissions associated with large industry and electricity generation installations across the EU. There are currently 101 such installations in operation in Ireland, of which 75 are industrial installations, with an installed capacity of more than 30MW. The ETS component comprises about 45% of EU emissions, but only 28% of total emissions in Ireland (Fig. 6)[22].

<u>Non-ETS</u>
The 2009 Effort Sharing Decision (ESD) (Decision No. 406/2009/EU) set individual Member State targets for non-ETS emissions (i.e. those associated with heating in buildings, transport, agriculture, etc.). The 2020 target agreed for Ireland is that non-ETS emissions should be 20% below their 2005 level. 78% of GHG emissions in Ireland are in the non-ETS category (Fig. 6)[22].

[19] http://ec.europa.eu/eurostat/statistics-explained/index.php/Greenhouse_gas_emission_statistics

[20] http://edgar.jrc.ec.europa.eu/overview.php?v=CO2ts1990-2015

[21] Energy White Paper. 2015. Ireland's Transition to a Low Carbon Energy Future, 2015-2030. Department of Communications, Energy and Natural Resources. http://www.dccae.gov.ie/documents/Energy%20White%20Paper%20-%20Dec%202015.pdf

[22] National Mitigation Plan. July 2017. Department of Communications, Climate Action and Environment. http://www.dccae.gov.ie/en-ie/climate-action/publications/Documents/7/National%20Mitigation%20Plan%202017.pdf

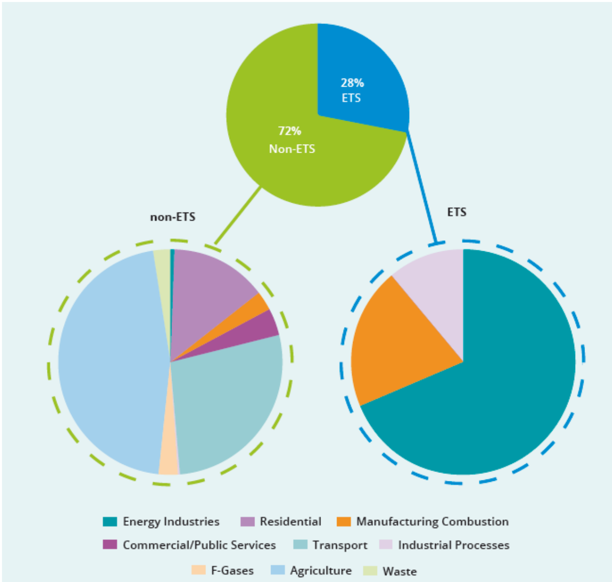

Fig. 6. ETS/non-ETS breakdown of emissions in Ireland (2015 figures)[22].

The breakdown of total emissions (ETS and non-ETS) by sector in Ireland in 2015 is shown in Figure 7. The largest contribution (33%) comes from the agriculture sector, with the transport sector at 19.8% and the energy industries sector at 19.7% and the residential sector at 10.1%. These are the key areas that require immediate and urgent focus in order make a significant difference in emissions.

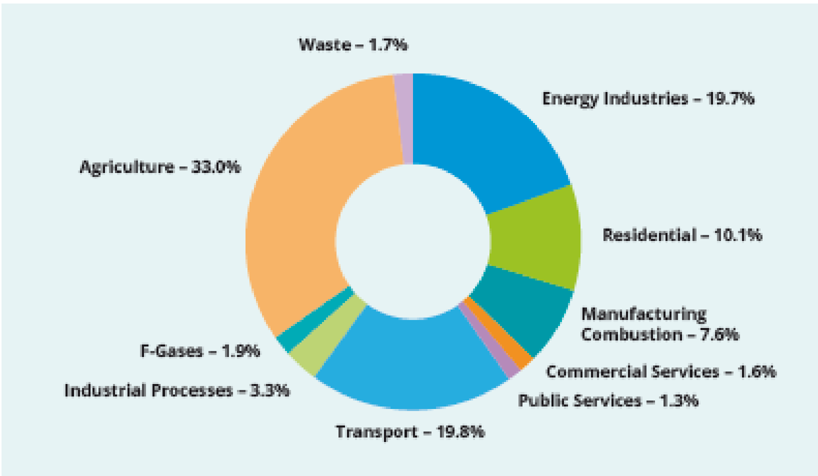

Fig. 7. Total emissions (ETS and non-ETS) by sector in Ireland in 2015[23].

EU policy dictates that emissions are treated differently depending on whether they originate in the ETS sector or the non-ETS sector. As pointed out in a recent ESRI report[24], this is suboptimal as the effect of carbon emissions on the environment is the same regardless of their origin. Another problem associated with ETS system is that it taxes the production, but not the consumption, of carbon emissions. There is thus an incentive to consume carbon-heavy goods produced in countries that do not tax carbon to the same extent as the EU,

[23] Draft National Mitigation Plan, March 2017. Department of Communications, Climate Action and Environment. http://www.dccae.gov.ie/en-ie/climate-action/consultations/Documents/4/consultations/DCCAE-National-Mitigation-Plan-Mar17.pdf

[24] Lynch, M.A. 2017. Re-evaluating Irish energy policy in the light of Brexit. ESRI Research Notes, 2017/2/1, 17pp.

resulting in what is known as 'carbon leakage'[25]. Additionally, recent research[26] found that a carbon price floor in the UK decreased carbon emissions from the UK but increased carbon emissions elsewhere.

A reform of the ETS system is required[27] in order to put an effective price on carbon and limit 'carbon leakage'. The separate treatment of ETS and non-ETS emissions is clearly suboptimal, does not provide an optimum method of tackling emissions and is therefore in need of major modifications.

Ireland's fossil fuel requirements

Ireland imports all its oil requirements of 6.5-6.6 million tonnes annually[8],[28] (equivalent to c. 137,000 barrels per day[3]) necessary for transport, industry and domestic use. Towards the end of 2015 Ireland imported 95% of its annual gas consumption of 4.1 Bcm (c. 400 MMscf/d)[3]. Gas, in particular, is an important fuel in Ireland both for heating and for electricity generation, and has the dual advantage of being relatively low in carbon emissions and having negligible emissions of sulphur and particulates.

Ireland currently has three sources of gas supply; a gas interconnection from Moffat in Scotland, the Kinsale field off the Cork coast, and the Corrib gas field off the northwest coast. Production from Kinsale is almost negligible[29] and is expected to cease production by 2020/2021. Corrib produces more than 50% of Ireland's requirements at present but production is projected to decrease to 50% of its initial levels by 2025. Current indigenous gas is not in a position to meet Ireland's annual gas demand and, in the absence of a further commercial gas discovery, Ireland will continue to rely on imported gas for the foreseeable future. In addition to meeting industry and domestic demand, gas is likely to be necessary for the coming decades in Ireland in order to provide the necessary base load backup for intermittent renewable energy sources such as wind and solar.

Ireland's has no direct link to mainland Europe gas or power networks, with the dominant gas supply point from as early as 2018 onwards likely to be the Moffat interconnectors[29]. Alternative supplies, either through imports or further indigenous discoveries and production, will backfill this production shortfall. If this alternative supply is imported gas, once again Ireland will be vulnerable to gas interruptions.

The UK currently imports more than 1 million barrels of oil equivalent per day to meet its needs, and UK energy import dependency is anticipated to reach 55% by 2030. 57% of the UK's gas needs (~70 Bcm per annum) are imported from Norway, Belgium and the Netherlands, as well as Liquefied Natural Gas (LNG) imports (mainly from Qatar).
33% of Europe's gas comes from Russia, while 21% comes from Norway[30]. Ireland, however, remains heavily reliant on the UK for gas. This also illustrates the vulnerability of

[25] Kuik, O. and Hofkes, M. 2010. Border adjustment for European emissions trading: Competitiveness and carbon leaking, *Energy Policy*, Vol. 38, Issue 4, 1741-1748.

[26] Curtis, J., Di Cosmo, V. and P. Deane, P. 2013. *Climate policy, interconnection and carbon leakage: the effect of unilateral UK policy on electricity and GHG emissions in Ireland*, ESRI Working Paper 458.

[27] Cameron, H. and A. Teytelboym, A. 2017. Climate change policy after Brexit, *Oxford Review of Economic Policy*, Vol. 33, Number S1, pp. S144-154. Available online: academic.oup.com/oxrep/article/33/suppl_1/S144/3066072/Climate-change-policy-after-Brexit.

[28] http://www.seai.ie/Publications/Statistics_Publications/Energy_in_Ireland/Energy-in-Ireland-1990-2014.pdf

[29] Gas Networks Ireland (2016). *Network Development Plan 2016*.
www.gasnetworks.ie/Global/Gas%20Industry/BGN%20Gas%20Industry%20Website%20Content/Gas%20Industry%20Documents/GNI_NetworkDevPlan_2016.pdf.

[30] https://www.britishgas.co.uk/the-source/our-world-of-energy/energys-grand-journey/where-does-uk-gas-come-from

Ireland's exclusive reliance on gas imports from the UK when it, as an energy importer itself, will lie outside the EU.

Supply interruptions in Ireland can be partly mitigated by use of either strategic oil reserves or stored gas. However, part of Ireland's strategic oil reserve of 90 days' supply (required under EU law) is held overseas in other EU Member States. Ireland currently holds oil stock agreements with Denmark, UK, Netherlands, Spain, Sweden and Germany. The arrangement to store oil in the UK will have to be reassessed in the light of UK withdrawal from the EU. Kinsale Head currently stores some strategic gas supplies but this facility will be decommissioned soon, further increasing the exposure to supply interruptions. An ESRI Working Paper (2010)[31] estimated that the cost of losing one day of gas-fired electricity amounts to €0.1-1.0 billion, depending on the timing and the rationing scheme used. The cost of losing three months of gas-fired power could be as high as €80 billion or 50% of GDP. Losing gas for heating for three months would add another €8 billion on average. Corrib currently provides a significant element of protection against this.

It is essential for Ireland, with a small and relatively isolated energy system, to identify the appropriate energy mix that will guarantee reliability, security and affordability, and ensure that it remains competitive in the transition period as outlined in the Energy White Paper (2015)[21]. Ireland needs to careful not to invest too heavily in unproven renewable energy technologies, many of which have been worked on for years or decades globally without a significant technological breakthrough in scale or reliability.

The most secure strategy to achieve Irish energy independence remains exploration and development of indigenous offshore natural resources. Brexit-related and other international energy security uncertainties reinforce the importance of supporting this strategy. Gas is of particularly importance as Ireland is heavily reliant on imports from the UK through the Ireland-Scotland interconnectors. In addition to the security of energy supply afforded by indigenous oil and gas supply, the successful development of indigenous offshore hydrocarbons will provide a significant incremental source of revenue to the Irish Exchequer – monies that could be used to support the transition to a low carbon economy. It is imperative that a competitive fiscal regime, robust and simple regulation and political leadership support exploration, development and production activities in Ireland's offshore.

At the end of 2015, a total of 25.3% of electricity, 6.5% of heat and 5.7% of transport energy requirements were met from renewable sources[22]. A total of 9.1% of Ireland's overall energy requirements in 2015 were met from renewable sources. This illustrates the magnitude of the challenge facing Ireland in the transition to a low carbon economy. An appropriate energy mix will be critical for the transition. This will, of necessity, involve continued use of fossil fuels, decreasing over time, with a move towards increasing use of gas to replace coal and oil. This is consistent with the aspirations of the Energy White Paper (2015)[21] which recognizes that oil and gas will play an important role in the transition to a lower carbon future. Indigenous gas has the potential to enhance Ireland's economic development underpinned by security of affordable energy. The Energy White Paper (2015) acknowledges that "*Ireland's indigenous oil and gas resources has the potential to deliver significant and sustained benefits, particularly in terms of enhanced security of supply, import substitution, fiscal return, national and local economic development and technology learning*."

[31] Leahy, E., Devitt, C., Lyons, S. and Tol, S.R.J. 2010. The cost of natural gas shortages in Ireland. ESRI Working Paper No. 397, 38pp. https://www.esri.ie/publications/the-cost-of-natural-gas-shortages-in-ireland/

The import of Liquefied Natural Gas (LNG) could offer an attractive means of diversifying gas supply. LNG has an advantage over new pipelines as the gas can be imported in liquid form from different gas markets worldwide. The Shannon LNG project at Ballylongford in north Kerry has planning permission but currently is not being developed[29]. In July 2017, NextDecade, a USA liquefied natural gas development company, signed a Memorandum of Understanding with the Port of Cork Company to advance a joint business development opportunity for a new Floating Storage and Regasification Unit and associated LNG import terminal infrastructure[32]. Increased gas imports from LNG also allow for the possibility of exporting gas to the UK[24].

Indigenous hydrocarbons (oil and gas) offer significant advantages over imported sources. In addition to the obvious economic savings and the enhanced energy security (both of which are important for economic wellbeing and prosperity), there are also environmental advantages. Imported hydrocarbons, pipeline or LNG regasification experience increased fugitive emissions (1-4%) during transport. Substituting such imports with indigenous supplies can make significant emissions reductions.

CCS storage for Ireland

In addressing the misconception that most of the remaining oil reserves must be left in the ground to stop GHG emissions, it should be noted that the key problem is the non-captured emissions from hydrocarbons, rather than the exploration, production or use of hydrocarbons themselves. Carbon Capture and Storage (CCS) can mitigate significant amounts of such emissions, thereby allowing the use of hydrocarbons as a transition energy form in the medium term until reliable and affordable substitutes can be developed.

A report carried out in 2008 evaluated the potential for Carbon Capture and Storage (CCS) in Ireland[33]. This showed negligible potential for onshore CCS storage but significant potential for CCS capacity in the offshore, either utilising gas fields that are coming to the end of their producing life, or in other geological structures. However, the use of CCS in Ireland is currently not permitted[34]. In the context of being able to continue using carbon-emitting energy sources during the transition period to a low-carbon economy, it would be prudent that Ireland should consider either (a) evaluating the Irish offshore and onshore potential to develop indigenous CCS facilities, or (b) consider exporting captured gas via pipeline to e.g. Scotland which has a CCS capacity or to EU.

Key Recommendations

- Establish an appropriate energy mix in the transition to a low carbon economy. In particular, increase the use of gas by enhancing interconnection within Ireland, to substitute for fossil fuel sources with higher emissions.
- Enhance efforts to replace imported energy with indigenous sources through the transition. This should involve supporting offshore oil and gas exploration.
- Diversify energy sources to avoid undue exposure to the risk of failure of a single source. In particular, consideration should be given to LNG, which as significant potential as a marine and road haulage fuel being cleaner than diesel and much cleaner than heavy fuel oil.
- Revisit CCS and CCU opportunities for Ireland.

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[32] http://next-decade.com/2017/07/nd-cork-mou/

[33] Assessment of the Potential for Geological Storage of CO2 for the Island of Ireland. 2008. Report prepared for Sustainable Energy Ireland, Environmental Protection Agency, Geological Survey of Northern Ireland, Geological Survey of Ireland.
http://www.sei.ie/Publications/Statistics_Publications/EPSSU_Publications/Commissioned_Research/Commissioned_Research.html

[34] http://www.irishstatutebook.ie/eli/2011/si/575/made/en/print