CASE
Centre For Advanced Sustainable Energy

THE BRYDEN CENTRE

CLEAN ENERGY

A POSITIVE FUTURE FOR NORTHERN IRELAND BUILDING ON OUR STRENGTHS

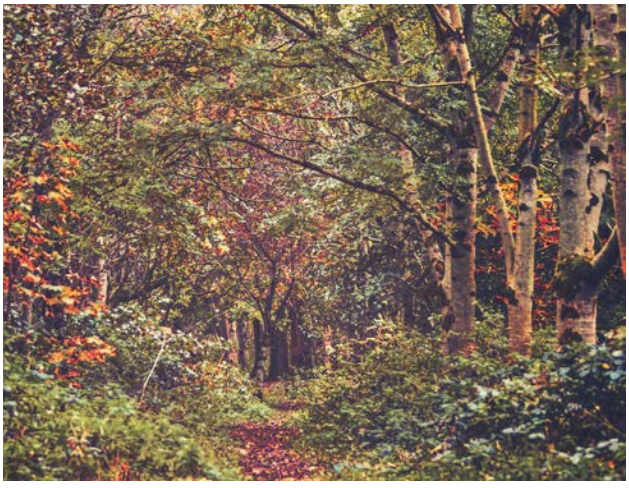
Invest Northern Ireland

Interreg
EUROPEAN UNION
Northern Ireland - Ireland - Scotland
European Regional Development Fund

EXECUTIVE SUMMARY

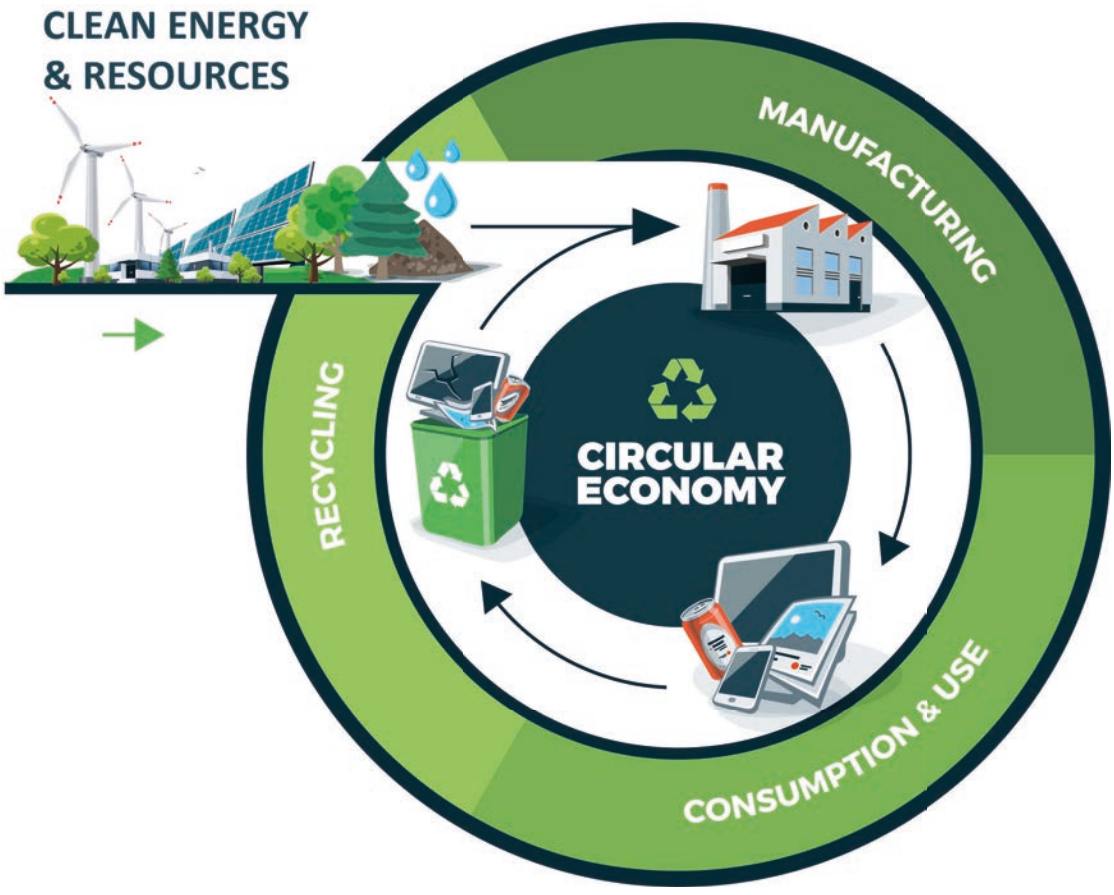
Clean energy is the future, protecting us from climate change and achieving low environmental pollution and better health. A carbon net-zero economy by 2050 will require zero-emission transport, heat, industry processes and agri-food sector. This can only be delivered when powered by renewable energy. We therefore welcomed the DfE paper "Rebuilding a stronger economy - the medium-term recovery towards a more competitive, inclusive and greener economy". Clean, inexpensive energy supplies will make our whole economy more globally competitive with our key sectors of advanced manufacturing, digital and life sciences gaining significant advantage. Recognition that clean energy is the foundation of the economic recovery is an astute conclusion.

Northern Ireland has abundant natural resources (wind, wave, tidal and solar) that could make us a net exporter of green energy. Linking our plentiful energy supplies to our strong agri-food sector offers substantial opportunity to remove dependence on expensive imports of fossil fuels, create high paying jobs and tackle rural poverty. Achieving this connection will solve the farm waste and pollution challenges that intensive farming generates and increase farm incomes.



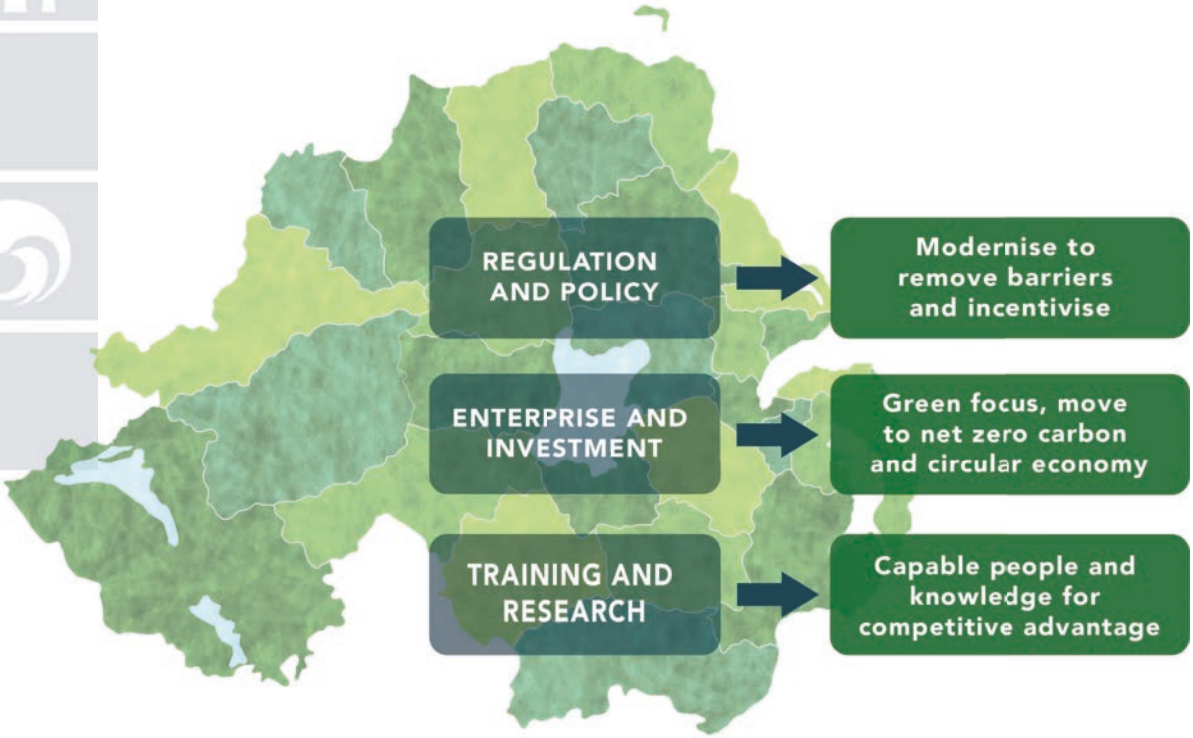
The transition to clean energy must rebalance the economy and deliver increases in prosperity, health and wellbeing for urban and rural communities across Northern Ireland. As we face the challenges to our economy post-pandemic, clean energy and the agri-food industry are probably best placed of all sectors to lead a revival of growth in jobs and incomes across rural and urban communities.

Here at Queen's we have been working through CASE and the Bryden Centre to enable a green, circular economy in NI. We have demonstrated how industry focused research and innovation in renewable energy and circular economy approaches can create jobs, attract inward investment and give local companies an innovation boost to increase market opportunities. We link local companies to world-class research capabilities they couldn't otherwise access and provide the highly skilled future employees that are essential for competitiveness on the global stage. CASE and the Bryden Centre, both led by Queen's University, along with their industrial partners are at the forefront of developing clean energy solutions for Northern Ireland



Following the lead offered by DfE we have asked our wide industry network to identify ready opportunities that would deliver high value. These we have grouped into three categories:

- Low cost regulation and policy options
- Enterprise and investment
- Training and research



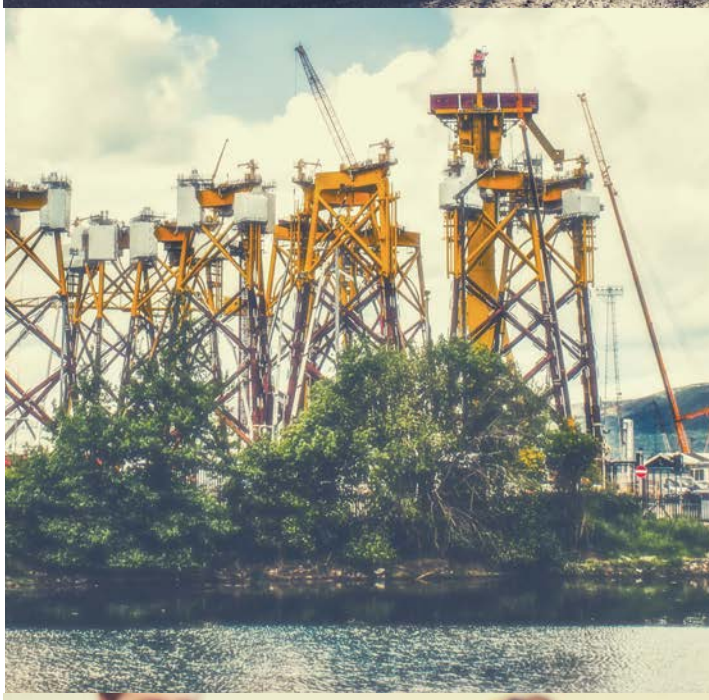
Successfully achieving the desired outcomes will come at no or low additional cost to current expenditure plans in most cases. Where possible we have identified steps using existing resources and suggest actions or changes in investment priorities to deliver the economic and societal benefits that are sought.

Sustaining the recovery and transformation of the economy in the medium to longer term will require laying the foundations now. Establishing and ramping up the training capacity for both new entrants to employment and for re-skilling those people displaced from sunsetting industries will take time. Equally, a competitive advantage for local enterprise will necessitate a focus on investment on support for green innovation and research to underpin Northern Ireland's circular economy and zero-carbon future. Training and research will require modest investment but will return value to our economy that is many multiples of the initial outlay.

MAIN RECOMMENDATIONS

POLICY AND REGULATION

1. Enable markets through developing a regulatory regime that supports a holistic energy system and circular economy in NI
2. Green the NI gas economy by permitting the injection of Biomethane and Hydrogen into the gas grid



ENTERPRISE AND INVESTMENT

1. Selectively support new commercial stage clean energy and decarbonisation projects that provide new jobs and economic growth – CASE and the Bryden Centre can help assess and recommend projects
2. Look to get high-level agreements in place to allow NI companies to participate as local suppliers in the RoI offshore sector to secure existing employment and create new job opportunities
3. Be bold in considering and then supporting what NI could achieve in a new global green hydrogen sector

TRAINING AND RESEARCH

1. Invest in essential support for future sustainable clean energy research, innovation, training and re-skilling
2. Work in partnership with sustainability focused research centres and institutes to translate research into economic growth

CASE AND THE BRYDEN CENTRE – QUEEN'S UNIVERSITY LED, CLEAN ENERGY RESEARCH AND INNOVATION FOR NORTHERN IRELAND

CASE – Centre for Advanced Sustainable Energy is an industry-led research centre funded through InvestNI's competence centre programme. Led from Queen's University with Ulster University and AFBI as partners we are transforming the Northern Ireland sustainable Energy Sector through business-led innovation and research. We cover all forms of renewable energy including marine, wind and bio-energy as well as energy systems.

Our pro-active support for industry focused research projects has delivered:

- £8.7m of collaborative R&D support involving 70+ companies in the sustainable energy sector, creating investment (to date) of a further £3m from industry
- World first testing of tidal energy devices at scale, in array format in Strangford Lough
- Leveraging £9m of additional funding and new contracts to the Northern Ireland economy
- Development & testing of technology prototypes including nano-composite solar thermal panels, dual fuel vehicle systems, new battery technology, marine renewable energy foundations, new catalysts and energy from waste solutions

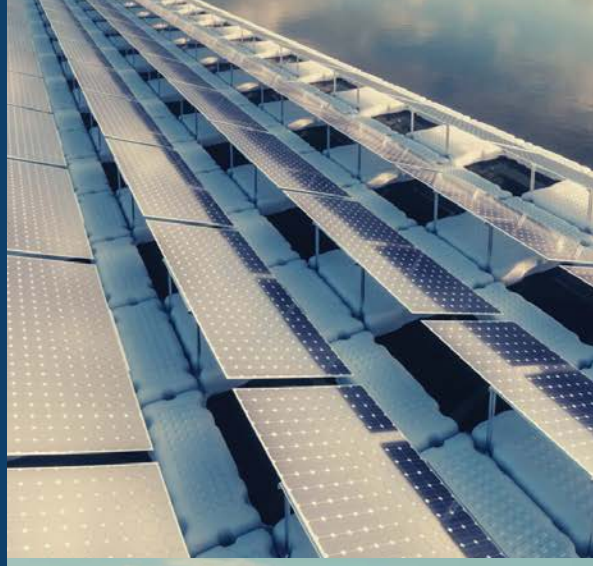
CASE
Centre For Advanced Sustainable Energy

The Bryden Centre is a cross-border, industry-led doctoral training centre undertaking research in clean energy. Our focus is on all aspects of marine and bio based renewable energy including environmental and social impact assessment as well as technology solutions. Our deep expertise covers a wide range of scientific, engineering and social science disciplines providing innovative solutions through world leading research. We aim to fully exploit opportunities to create a true circular economy, establish a culture of manufacturing for posterity and actively farm carbon from the atmosphere. The Bryden Centre is led by Queen's university Belfast with a number of partners including the University of Highlands and Islands, Letterkenny Institute of Technology, Ulster University and the Agri-Food & Biosciences Institute. The Bryden Centre is funded under the Interreg VA programme.

Bryden Centre research at Queen's University has enabled:

- A County Down based biogas plant operator to work with Rolls Royce Power Systems on a carbon capture and utilisation project for the Biomethanisation of CO_2 from their biogas plant with green hydrogen to produce biomethane for Rolls Royce Power Systems to fuel their heavy engines.
- Support to major regional manufacturers including Encirc to decarbonise production
- Help for regional companies including Colloide and Elmgrove to create new jobs which develop Nature based solutions creating added value products from agricultural waste while reducing, ammonia emissions and excessive pollution – diversifying income streams for farmers

THE BRYDEN CENTRE



OPPORTUNITY

REGULATION AND POLICY

How we can help:

- Independent expertise for technical advice, modelling and representation on regulatory and standards committees
- Access to industry leaders for consultation, piloting or field investigations
- Access to outputs from our research to validate new regulation and policy changes

Economies and industries are in transition. Climate change, environmental pollution and sustainability of societal consumption are all driving new approaches. In Northern Ireland development of a new Strategic Energy framework and a push to decarbonise the electrical grid and industry requires a reassessment of policies and regulations. Rules that were appropriate when coal was predominant and landfill an easy waste solution no longer apply. Developing a policy and regulatory framework that removes barriers, enabling optimum use of clean energy, a sustainable circular economy and responds to climate change drivers is essential.

Government policy and regulations that deliver that policy have a strong role in enabling markets while ensuring protections for people and the environment. Good regulation aids and encourages trade through creating a level playing field, creating accepted standards that give confidence to investors through defined performance criteria giving certainty to investment. Without appropriate regulation the world we inhabit would be a less pleasant and less healthy place.

Regulation has evolved as we learn more about social and environmental harms and with technological progress. It is widely recognised that as our society evolves to be more sustainable, we need to be much more open to re-using, re-purposing and re-cycling. The concept of waste in a circular economy must be reconsidered. Today's waste in a circular economy is tomorrow's raw material and has substantial value.

Melting scrap metal to produce new products has long been accepted and welcomed. Similarly, reusing glass and plastic waste as feedstock has growing economic value and regulation enables and supports this activity. Organic waste (farm slurries, food waste, crop residues etc.) has yet to be fully acknowledged as having the same potential. Limited use for energy generation and spreading as fertiliser on land are permitted with strict controls[1]. Other products derived from organic waste have to be treated as waste for handling, processing and storage. This closes markets to material recovered from organic wastes including carbon and non-carbon products. For example, high purity ammonia can be economically extracted from processed farm wastes but even with no organic residue it still has to be treated under the waste regulations. This is a nonsense.

[1] The Waste Regulations (Northern Ireland) 2011 (SR 2011 No. 127) interpreting Directive 2008/98/EC

Opening markets for biogenic carbon products and other chemicals derived from organic waste not only creates value and income for farmers from slurries and crop residues, it also enhances rural economies, creating jobs and local enterprise. Environmentally, this would dramatically reduce air, land and water pollution from ammonia, phosphorus and other nutrients as well as potentially acting to permanently remove carbon from the atmosphere. Delivering minor tweaks to regulations to expand permitted activities using proven technologies would be sufficient to attract investment and allow organic waste to be a high value component in Northern Ireland's future zero-carbon economy.

Adapting waste regulations and consultation on changes can take time, especially where coordination with other administrations is required. This does not prevent local permitting for exploratory activities such as pilot plant development and impact assessment. One area that will bring immediate gains is a simple change to allow biomethane to be injected into the gas grid. Northern Ireland should follow GB and RoI in reducing our fossil fuel footprint while expanding markets and jobs in the NI biomethane sector.

The biogas to electricity in NI is well establish through support of the NIROC scheme. According to UK Government regional renewable energy statistics, as of the 31st December 2018 there are 105 biogas sites generating electricity in NI with an electrical generation capacity of ~56MW. The establishment of the biogas sector in NI was funded mainly by equity from outside the region and resulted in an inward capital investment of over £350M in the last 5-6 years and has secured ongoing incomes of ~£120M per year backed by UK Government 20 year guarantees under the NIROC Scheme. These incomes secure ~5,500 jobs in the sector, the majority of which are in rural communities.

Biogas plants are not location specific and are distributed throughout NI. Due to the high level of availability of a biogas plant (+80%) and their wide geographical distribution, the plants provide significant levels of grid strengthening and stability for the NI electrical grid. However, the development of new biogas projects has halted due to the lack of financial incentive for renewable electricity in NI, since the closure of the NIROC Scheme.

In terms of future decarbonisation of NI to meet Net Zero targets, renewable heat and renewable transport have been identified as two hard to address sectors. Biogas, which is 55 to 60% methane can be upgraded to 95%+ methane to reach natural gas grid standards and injected into the grid as biomethane. The recent UK Government consultation "Future Support for Low Carbon Heat" has specifically identified biomethane, *"To meet our legally binding emissions reductions targets, we need to reduce our dependence on burning natural gas to heat our homes. Biomethane injection into the gas grid accelerates the decarbonisation of gas supplies, by increasing the proportion of green gas in the grid. This transition is a necessary step towards meeting our carbon reduction targets, including the UK's net zero greenhouse gas emissions target. We expect the Green Gas Support Scheme will contribute 9.7MtCO_2e of carbon savings over Carbon Budgets 4 and 5, and 21.6MtCO_2e of carbon savings over its lifetime"*

The importance of biomethane to decarbonise the heat sector in NI was highlighted in a recent report published by Ulster University, "Zero in on NI Heat";

"Biomethane and hydrogen are two major technologies currently considered to replace natural gas and supply heating to consumers that already have gas connections. The obvious opportunity for these technologies is to utilise the already developed gas infrastructure and ensure maximum benefit for taxpayers (and gas consumers) money spent on its development. This opportunity is even more important for NI consumers, considering that the gas grid is relatively new and some parts of it are still under development. Unprecedented political and business support is another opportunity driving decarbonisation of the natural gas subsector globally"

In a recent report prepared for DfE on the "Future of Renewables in Northern Ireland" several stakeholders viewed biogas conversion to biomethane for injection into the natural gas grid as preferable to the conversion of biogas to electricity. The report, as well, highlighted the large biomethane potential in NI, based upon work carried out by The Department for Agriculture, Environment and Rural Affairs (DAERA)

"DAERA 2019 report on reducing emissions in NI took a positive view on biomethane production stating that NI could produce 130 – 580 million m^3 of biomethane per year to generate up to 2,000GWh of power or heat annually"

As at December 2019 NI imported 17,000GWh of natural gas the previous year for both power and heat generation. Therefore, a substantial proportion of the imported fossil natural gas could be displaced with zero carbon renewable biomethane. This will have the double decarbonisation benefit to NI by capturing carbon emissions from the agricultural sector to displace imported carbon emissions from natural gas.

However, the report underlined the lack of financial incentive available in NI for the injection of biomethane into the natural gas grid in NI, compared to GB. Also, another issue is that, unlike GB and RoI, biomethane cannot be currently injected into the natural gas grid because of a lack of legislation from the NI Executive.

NI has the opportunity to develop innovative next generation biomethane production facilities which not only produce biomethane but will also recover problematic ammonia and phosphate thereby improving the environment. NI is the ideal location to deliver this opportunity.

In terms of early easy wins, aligning NI policy and tariffs for the injection of biomethane into the gas grid with those already available in GB and RoI would be a significant achievement in NI meeting it's 2030 net zero target. This would also provide for a major boost to economic growth and job creation, particularly in rural regions in NI.

RECOMMENDATIONS:

- **Enable markets through developing a regulatory regime that supports a holistic energy system and circular economy in NI**

- **Green the NI gas economy by permitting the injection of Biomethane and Hydrogen into the gas grid**

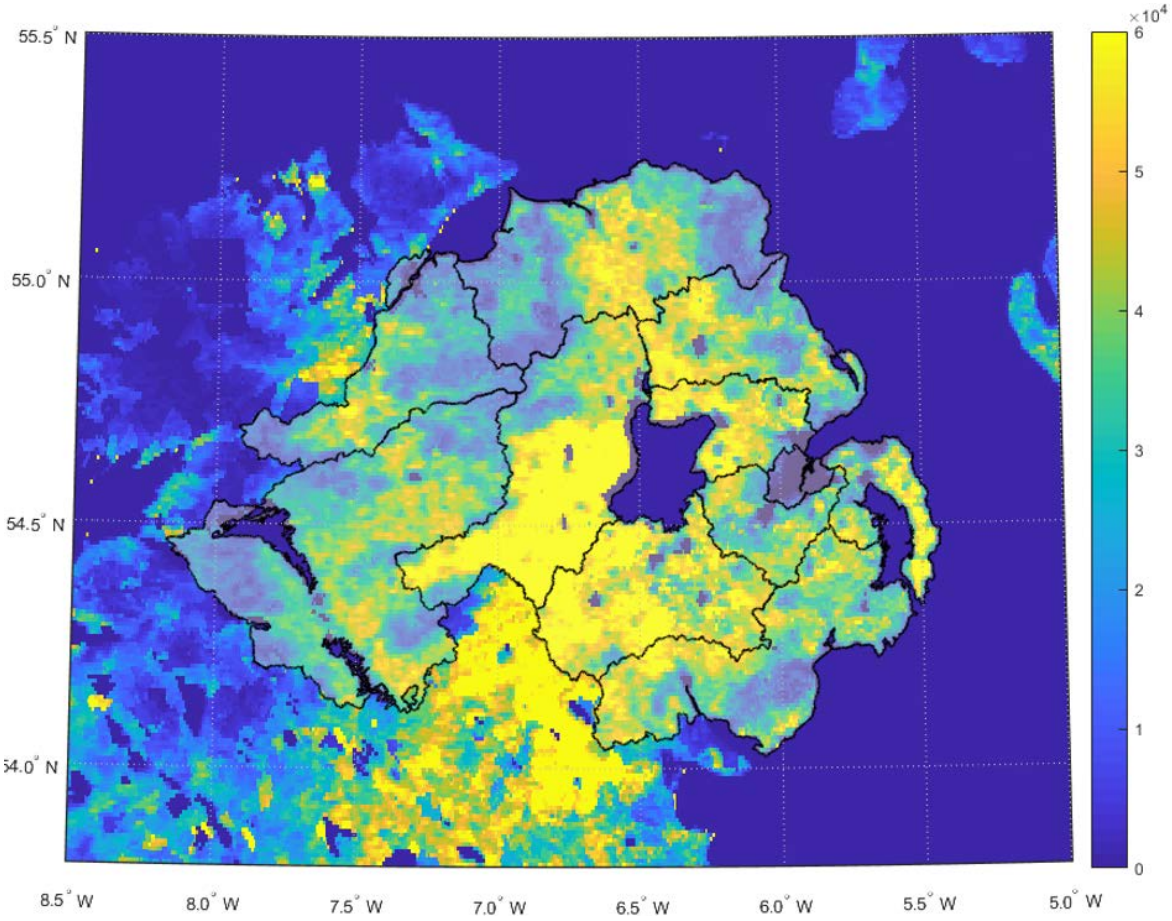
OPPORTUNITY

ENTERPRISE AND INVESTMENT

HOW WE CAN HELP:

- Identification and evaluation of 'shovel ready' projects and opportunities for quick, high return actions
- Ability to work across and link sectors and resolve competing interests
- Direct support across the research spectrum from testing initial concepts to product innovation and translation to market
- Support to innovators and entrepreneurs

Government has to set the incentive and regulatory environment to encourage and persuade all parts of the Northern Irish economy to move to clean energy and decarbonise their activities. Apart from NI government's own activities and estate, NI government currently has no direct control over the adoption of sustainable practices, green energy and decarbonisation. The decisions and major investment needed have to come from business, third sector organisations and households.

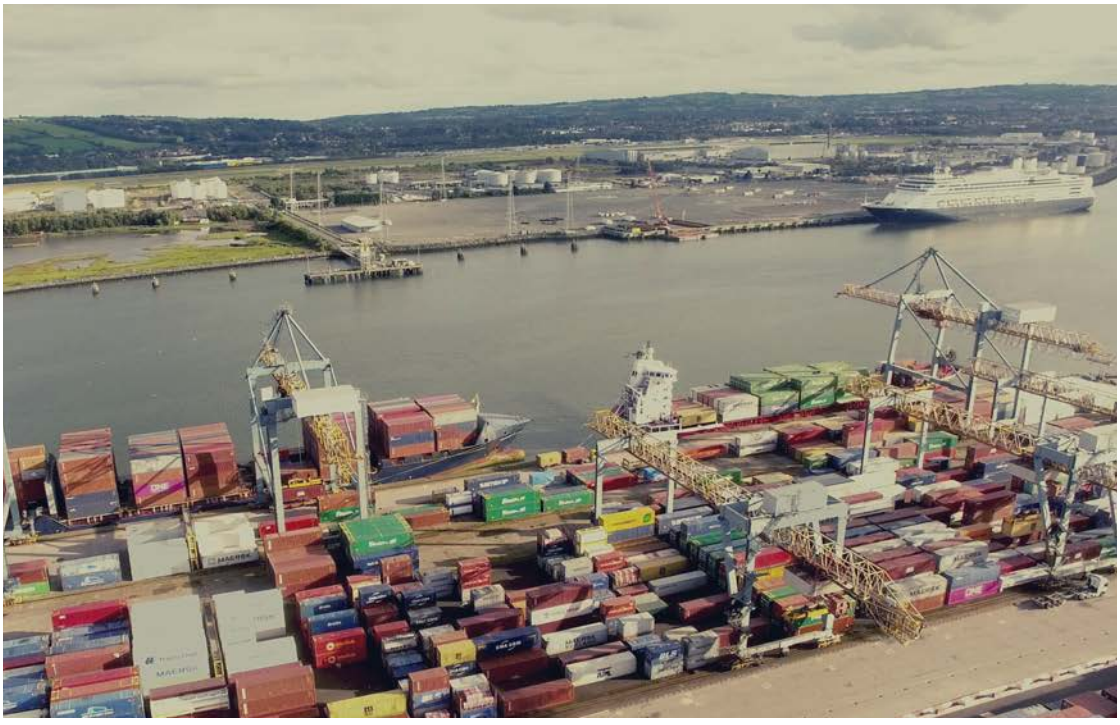


The new gold? Biogas potential from agricultural waste across NI

The investment decisions offering quick returns by reducing use or decarbonisation of energy have mostly already been taken by industry. Further measures are possible and economically sensible, but they have to compete for limited investment funds against the more immediate returns offered by other choices such as new capital equipment or new product development. Incentivisation both by grant and by pricing carbon are essential components to strengthen investment cases for substantially reducing emissions from industry, especially those dependent on non-electrical heat or who emit greenhouse gases due to the processes that they use.

Through our work directly with industry, trade and other sector bodies both CASE and the Bryden Centre have strong relationships with business leaders and a deep understanding of the energy challenges they face. These links stretch across borders to business and research providers in the UK and Ireland as well as all-Ireland organisations such as the Marine Renewables Industry Association and the All-Ireland Climate and Biodiversity Research Network. Leveraging these connections gives insight and perspective on difficulties in migration to clean energy and awareness of projects which, with a little support, could rapidly create jobs, carbon savings and prosperity. A selection of such opportunities is included later.

One of the biggest opportunities for protecting and growing manufacturing jobs is from developing new markets for existing manufacturers such as such as McLaughlin and Harvey, Harland & Wolff, Cimpina and Belfast Harbour. The planned 5GW of offshore wind off the east and south coasts of Ireland by 2030 is a major prospect. At present, there is exactly 25MW in the water in the world's second oldest offshore wind farm, Arklow. The IWEA supply chain report suggests three port clusters will be required to support the new activity. These do not currently exist. However, Belfast is fully equipped and capable of supporting the Irish Sea wind farms. Second, the local supply chain in RoI is estimated to be able to meet only 22% of the value of the requirements. This is unlikely to see a big uplift as local industry is geared to higher value-added activity such as Pharma and due to a lack of engineering tradition, may not be attracted into the field. Conversely, advanced engineering is a cornerstone of NI's economy and with agreement between the NI Executive and RoI governments could become eligible to be treated as part of the local supply chain to drive up the value to this island.



Similar opportunities lie in north-south cooperation in decarbonisation and clean energy more generally, especially with common electricity and gas grids. Solutions for energy generation and cross-linking to other sectors, such as agri-food, will be easily deployable across borders and offer a large market for NI technology.

Green hydrogen is one area where global investment has dramatically grown in the past year. Now seen as the solution to many of the most intractable decarbonisation challenges, green hydrogen is viewed as the fuel of the future. A strong candidate for enabling the displacement of fossil fuels in land and water-based heavy transport of goods and longer-term for medium range air transport, green hydrogen could also play a role in inter-seasonal energy storage and decarbonisation of some industrial processes.

To generate green hydrogen, low-cost power generation is essential as well as inexpensive electrolyser technology. Northern Ireland is well placed to succeed and become a net exporter of this new fuel. We have the abundant natural resources to provide the inexpensive power, potential to manufacture electrolysers and one of the few locations in Europe with the geological potential to store hydrogen at volume in salt caverns.

RECOMMENDATIONS:

- **Selectively support new commercial stage clean energy and decarbonisation projects that provide new jobs and economic growth – CASE and the Bryden Centre can help assess and recommend projects**
- **Look to get high-level agreements in place to allow NI companies to participate as local suppliers in the RoI offshore sector to secure existing employment and create new job opportunities**
- **Be bold in considering and then supporting what NI could achieve in a new global green hydrogen sector**

PROJECT FOR SUPPORT/ACTION

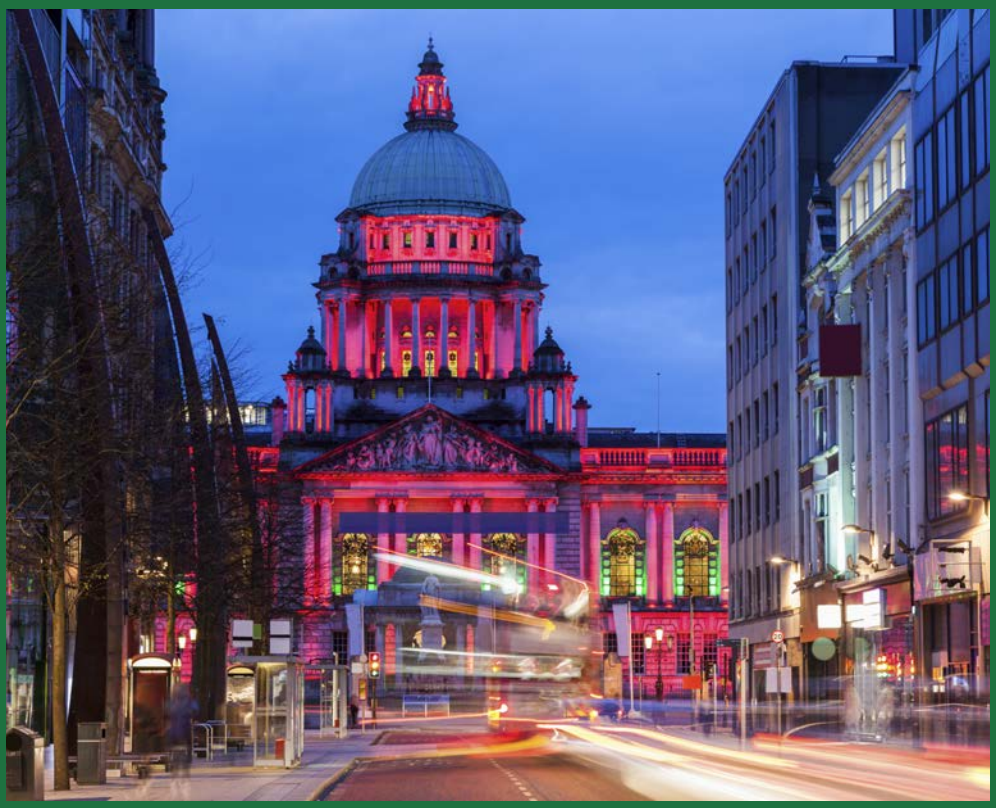
GREEN HYDROGEN SUPPLY CHAIN

B9 ENERGY AND CLEAN POWER HYDROGEN GROUP

Green hydrogen is seen as the fuel of the future for transport, heat, power and as a chemical feedstock for biogenic carbon industries. Across the world major investments are being made in green hydrogen plants powered by cheap renewable electricity. In Europe alone, plans for 40GW of electrolyser capacity by 2030 have been approved as part of the European Commission's hydrogen strategy. There is a huge and, as yet, unmet requirement for electrolyser production to meet global demand.

B9 Energy in partnership with Clean Power Hydrogen Group are intending to establish a factory in Belfast which will be the largest currently planned in the world, capable of producing 2GW of electrolysers each year. The membrane-free-technology being planned is unique, being faster in operation and more cost-effective than competitors. When built and operational this factory will employ between 700 and 1000 FTE staff and be spending up to £450m annually with local sub-contractors for the advanced manufacture of components and equipment, potentially creating many hundreds of additional high-value jobs.

Work to establish the factory is expected to start later in 2020. As a foundation of the hydrogen economy this will underpin many opportunities in the local economy, not just for engineering companies but also for the emerging 'Power-to-X' industry. Placement of a 2GW capacity factory in NI will position the region at the forefront of the hydrogen economy and is a major export opportunity.



OPPORTUNITIES FOR ACTION:

1. Green hydrogen is part of the solution to decarbonisation. Strong support for creating a hydrogen economy supply chain in NI will not only decarbonise our economy but will increase exports and minimise dependency on fuel imports
2. Advanced manufacturing is a strength of the NI economy. Marrying this to the clean energy revolution enables the exploitation of considerable synergies, creating large numbers of well-paid jobs across the region. Facilitating this cross-linking is vital

PROJECT FOR SUPPORT/ACTION

DE-CARBONISING TRANSPORT

ENCIRC

Transport by HGV is one of the essential components of the economy. Options for reducing the carbon footprint are currently limited with green hydrogen and high energy density batteries yet to be commercially viable. Biogenic fuels derived from energy crops or organic waste are the only market ready options currently available. Encirc manufactures glass containers for the food and beverage industries. Derrylin in Fermanagh is home to one of three Encirc sites. This factory employs 450 people and manufactures 1 billion containers each year. Transport of glass goods is a major part of operations with 60% of them leaving the island of Ireland.

Diesel consumption for trucks is 1.6M litres per year and accounts for ~5% of the total fuel consumption of the Derrylin site. Switching over to more sustainable lower carbon fuels is a significant decarbonisation opportunity with around 4,000t of CO_2e to be saved per year. Encirc are planning to start a trial in the autumn on switching their trucks over to renewable diesel. However, the company has concerns regarding renewable diesel:

- The security of supply of renewable diesel, the majority of which is imported into Ireland
- The sustainability of the fuel in terms of the source
- Air quality, as with fossil diesel, renewable diesel combustion results in particulate emissions

Encirc has identified biomethane as an additional potential alternative fuel for their fleet. Biomethane can be sourced from biogas plants on local farms and is a cleaner burning and a lower carbon fuel than renewable diesel, with a negative carbon balance if the biomethane is produced from animal manure. However, experience of running biomethane/natural gas fuelled trucks in Ireland is significantly less than that for diesel fuelled trucks and for this reason there is concern about maintenance of the trucks, on road performance and refuelling infrastructure.

OPPORTUNITIES FOR ACTION:

To better inform Encirc and HGV operators generally on switching to alternative fuels support for a proposal to expand the truck trial to include biomethane sourced from local AD plants is needed. This trial will be supported by CASE/Bryden centre researchers to collect and correlate data on trucks on their delivery runs fuelled by diesel, renewable diesel and biomethane. The trial will inform future policy decisions by government and investment choices by local transport companies. The manufacturing carbon footprint is a concern for the industry and the output from this research work would be a decision tool to inform as to potential alternatives to address Scope 3 emissions

PROJECT FOR SUPPORT/ACTION

POWER-TO-X

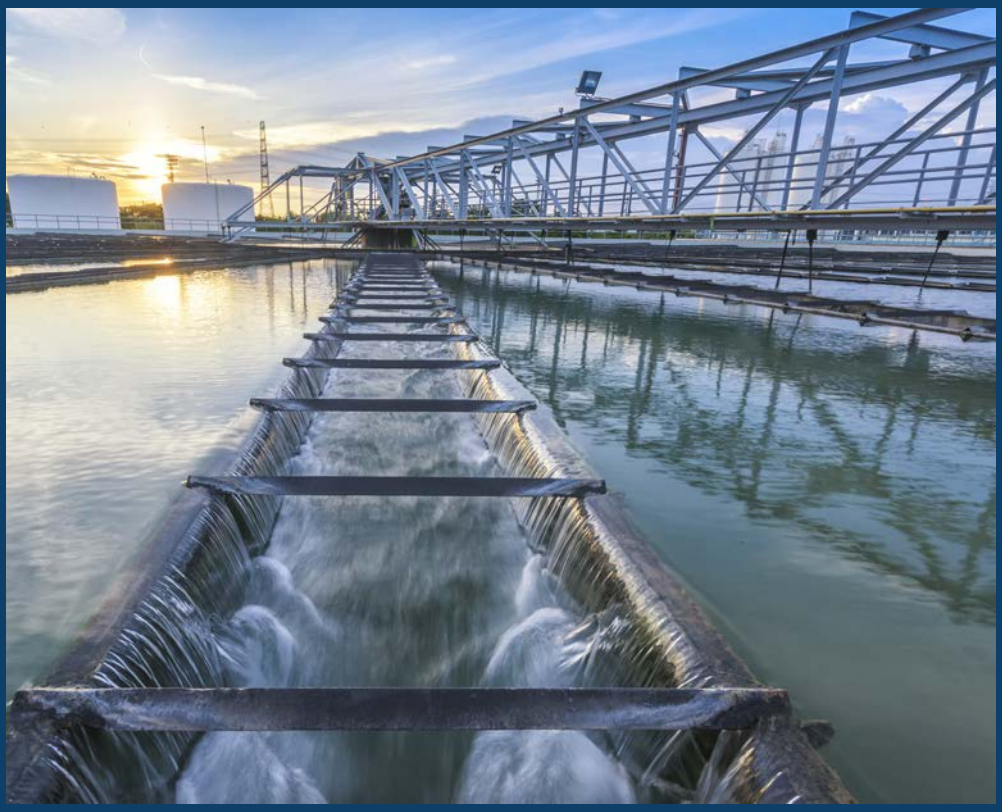
B9 ENERGY

Power from renewable generation is often too abundant and not connected to the electricity grid. This results in curtailed or constrained generation where electricity that is produced cannot be used. This is a challenge that also offers opportunity to new technologies such as green hydrogen production. Northern Irish company B9 Energy is planning to install 760MW of electrolysers at more than 30 locations across NI to take advantage from this excess generation capacity.

Creating about 100 well-paid jobs in total, half in B9 Energy and the rest at local suppliers and sub-contractors this project has many major benefits:

- Curtailed or constrained wind farms and stranded solar generation systems will have multi-MW routes to market their electricity and a balancing electrical load
- Green hydrogen production for heat, power, transport and feedstock for the circular chemical industry
- Green oxygen for wastewater treatment plants and oxy-firing
- Heat for processes and grid services for electrical security of supply

At present, work is progressing on a 1MW pilot plant at Kinnegar wastewater treatment plant for hydrogen production following on from a current oxygenation trial. This will be followed by a fully commercial, 27MW venture in Belfast. Support from Invest NI and SBRI funding has been critical to enabling this activity to progress.



OPPORTUNITIES FOR ACTION:

1. As renewable generation increases there will be a growing need to have balancing electrical loads for use of curtailed or constrained power. Consideration in planning and policy should encourage appropriate adoption of 'Power-to-X' and related solutions to maximise the local benefits from clean energy
2. Green hydrogen, oxygen and other derived chemical feedstocks will be essential for displacement of fossil fuels. Policy initiatives to support the development of local supply chains and markets will encourage investment, creating employment and advantage for Northern Ireland in the coming decades

PROJECT FOR SUPPORT/ACTION

BIOREFINERY

ENERCHEM SOLUTIONS

Agriculture plays a large part of the NI economy with many livelihoods' dependent on it for an income, directly or indirectly. At 28% of NI's CO_2e emissions compared to 6% in the UK, agriculture and land use must be a focus for decarbonisation. EnerChem Solutions has developed a biorefinery project to utilise farm waste streams not only to produce fuels but also as a heat source for district heating while reducing pollution and improving soil health.

The proposal is to locate the plant on a pre-existing site in Ballymena. Using excess waste streams which are grass based (ability to sequester 6.83 tonnes of CO_2 per hectare/year) this project will process waste through a system of technologies producing syngas/bio-oil, char which can be used as a soil conditioner and thermal energy to be distributed through a district heating network. This district heating network will provide thermal energy to local agri-food processors, concrete and construction manufacturers, the former Michelin Facility currently bidding as the logistics hub for the Heathrow runway expansion, as well as social housing (4000 homes) in the local council area of St. Patricks Barracks and i4C. These energy streams will provide competitive renewable energy resources to domestic and commercial consumers which will be decarbonised.

While having many environmental benefits and attracting support from the local council (M&EA) key barriers remain. The biggest is raising the external investment for the CAPEX for the biorefinery at approximately £15 million. Government is supporting the project but as there is no current funding scheme in place for low-carbon energy in NI the commercial risk is increased and this is limiting progress with the scheme. Delivery of the biorefinery is estimated to take 18 months after planning approval is granted. Once proven, similar biorefineries could be easily rolled out across NI, decarbonising the economy and solving key pollution and emission challenges in the agri-food sector. This is also a concept that could be readily exported to the UK, Europe and beyond.

OPPORTUNITIES FOR ACTION:

Introduction of incentives and support for significant decarbonisation initiatives in NI will leverage commercial investment and provide clean energy in the form of heat, power and fuels. Careful specification of support will also address pressing needs in the agri-food sector to decarbonise and effectively deal with waste streams to minimise pollution

PROJECT FOR SUPPORT/ACTION

BELFAST HARBOUR

Belfast Harbour has ambitious plans to decarbonise and achieve net carbon zero, potentially by 2030, becoming this island's greenest and smartest regional port. National, local and regional plans and recommendations from major reports are being followed to decarbonize the Belfast Harbour estate. This will transform the port into an innovative green hub for Northern Ireland and deliver the ambition of becoming the region's most sustainable developer (green construction, infrastructure, engineering, marine and small works).

To operate, maintain and develop the port sustainably, commitment at the top level will drive our green vision with science-based targets and actions. Belfast Harbour's 2035 strategy 'A Port for Everyone' aims to create 46,000 additional jobs and captures our green ambitions through the strategy's Green port and Smart port themes. Already we have achieved much, greening the harbour estate through moving to LED street and quay lighting, procuring green electricity and installing solar power generation as well as the City Quays 2 development achieving BREAAM excellent. Our goals for the future cover both our estate and business community and include:

- Renewable energy and energy efficiency targets
  - Harbour Estate electricity demands met through a combination of microgeneration (solar and wind) and green power procurement along with storage technology (battery) to meet our direct energy demand and that of our customers, visitors and businesses
  - Expanding the digitisation of much of our energy infrastructure to meter and monitor energy usage with the aim of achieving greater control, more efficient energy use and identification of where renewable energy or energy efficiency investment would be most valuable
  - Increased electrification of our vehicle fleet and exploring options for generation and use of green hydrogen, including attracting new green-hydrogen based businesses to the estate

- Enhancing the natural environment:
  - Improving water, air quality and ecological value of existing wildlife spaces (network of sensors and low emission zones for example and habitat management of reserves by wildlife NGO stakeholders)
  - City Quays Gardens project – increased accessible greenspaces with high ecological and biodiversity value (nature-based solutions planting to capture carbon and improve soil health)
  - Improve air quality and reduce emissions by displacing fossil fuels from transport and heating
- Implementation of circular economy approaches:
  - Reduce consumption of raw and virgin materials and greater reuse or use of recycled material across the estate including support for businesses to operate sustainable procurement practices
  - Recovery and reclaiming of waste material across the estate to stimulate a resource economy for NI
- Greening construction activities
  - City Quays 3 development continuing (£51.5m investment) with energy efficient design key to this build – aim to get BREAAM Excellent accredited
  - Reduction of construction waste to landfill and use of recycled building material where appropriate

OPPORTUNITIES FOR ACTION:

1. A substantial shift to a low carbon future will require new or refurbishment of much of our building stock and infrastructure. Green growth, lower carbon emissions and new job creation will be stimulated by:
   - Improving planning rules to encourage integration of hydrogen and other low zero carbon technologies, particularly for test bed or pilot schemes
   - Extending greener building codes to retrofit and refurbishment works
2. Protecting and enhancing the environment is essential for sustainable economic growth. Opportunities for development could be delivered faster and adapted to improve local ecology or maximise environmental protection with clearer policy and regulatory guidance. There are many examples such as working on or near protected marine habitats or reducing air and water pollution where better policy, regulation or legislation would be beneficial

OPPORTUNITY

RESEARCH AND TRAINING

HOW WE CAN HELP:

- Provide the highly trained engineers, researchers and other professionals required for a successful energy transition
- Deliver the research and innovation capacity essential for growing local clean energy companies
- Data gathering, analysis and advice for decision making and policy choices

Northern Ireland has a unique mix of environments, agriculture and rural communities. Delivering rural and regional prosperity, societal well-being in a rich and vibrant landscape is vital for our future. Education and Research plays a pivotal role in delivering the jobs, competitive advantage and economic success that are essential. Achieving our goals demands a highly skilled workforce and an ability to out-innovate competitors whilst leveraging our natural strengths:

- Abundant biogenic carbon, wind, marine, solar and geothermal resources
- A long heritage of world-class engineering and enviable biotechnology sector

CASE and the Bryden Centre are Northern Irish success stories. Both Centres will continue to deliver real benefits and highly qualified future employees through the remainder of their funding envelopes. Further investment will be required to maintain and extend current provision in order to profit from the energy transition, economically, environmentally and through reducing social deprivation across all our counties. Important requirements are:

- Expansion and extension of support for training the increased numbers of high skilled employees and researchers required by the energy transition beyond just PhD qualified scientists. This includes re-training people exiting from sunsetting fossil fuel industries, training new entrants to the jobs market as well as the graduate and post-graduate level future industry leaders

- Strength in research and innovation is critical as clean energy is driven by technological progress. Seizing the benefits of the transition for the local economy will be dependent on strong R&D foundations. Important will be more localised innovation hubs to interface with local industries and communities. We anticipate a strong demand for establishing increased support across different districts, utilising existing institutions or through establishing local innovation centres in partnership with councils or other bodies. This will deliver support to local businesses, government and councils through:

    - Research from feasibility studies to show proof of concept to give investor confidence and extend to research programmes to fully exploit NI technology and natural resources
    - Pilot demonstrators
    - Data collection and analysis to inform decision and policy choices
    - Cross-sectorial linking and innovation
    - Assurance to local and inward investors as to technology readiness and ability to fast-track solutions to production, process or product technical problems

Bringing together all actors to work in an integrated partnership is critically important so a coherent and comprehensive response can be delivered to the energy transition challenge. CASE and the Bryden Centre are great examples of how the principal research providers in Northern Ireland can work together to deliver the training and R&D requirements for the Northern Irish economy in clean and sustainable energy. Future sustainable, clean energy training and research at Queen's will be delivered as part of a broader sustainability commitment being developed in the university.

NEW APPROACHES TO MULTI-DISCIPLINARY CHALLENGES

Holistic, systems-based thinking is a necessity when looking not just to transition to clean energy but also when moving to a net zero carbon future that is fully sustainable and protects biodiversity and the environment. Economic, regulatory and social aspects need to be considered alongside the technology drivers. Research must play its part. Our Universities have a role both as hubs of science and engineering excellence and to facilitate and enable. Queen's University has already made great impact with projects such as the Bryden Centre, CASE, QUADRAT[2], Place-based Climate Action Network (PCAN)[3] and MISTRAL[4]. Communities, local and regional government, industry and academia come together in these activities to solve specific energy and sustainability related challenges.

[2] QUADRAT (https://www.quadrat.ac.uk/) is a doctoral training programme that brings together research and training centres of excellence in biological sciences and geosciences from the University of Aberdeen and Queen's University Belfast to focus on challenges in Biodiversity, Earth Systems and Environmental Management.

[3] PCAN (https://pcancities.org.uk/) is an ESRC-supported network that brings together the research community and decision-makers in the public, private and third sectors. Translating climate policy into action 'on the ground' in our communities to stimulate a vital flow of action, operationalising the Paris Agreement, UK targets and individual city ambitions to deliver place-based impact. The result will be healthier, more prosperous and resilient cities with reduced greenhouse gas emissions.

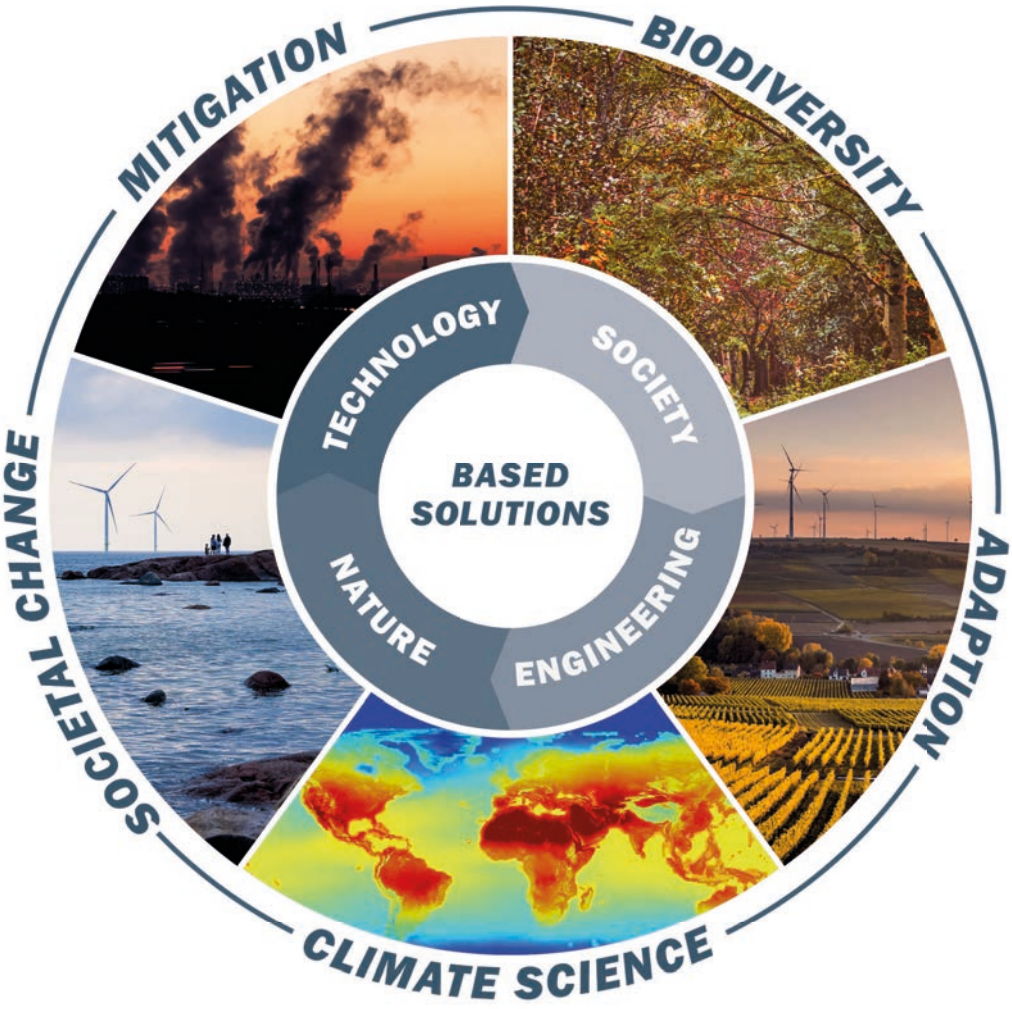
[4] MISTRAL (https://mistral-itn.eu/) is a European training network that aims to train a new generation of researchers who can evaluate the complexity of social acceptance issues facing the deployment of renewable energy infrastructure, and propose innovative solutions in a variety of research, government and business contexts.

These very successful projects have established Queen's leading position on energy and sustainability. Scaling up and enhancing these activities is absolutely critical to solve the energy, climate and environment challenges facing our region. A bold and exceptional initiative is being developed to establish a climate change and sustainability solutions approach at Queen's University (see Figure below for conceptual diagram). Not only does this marshal science, engineering and social science disciplines, it is intended that it will include at its very core, co-located policy makers and researchers from government and industry. No longer will there be segmentation between different sectors and barriers due to geography, separate interests or language.

Within this framework disciplinary led labs and platforms feed data into a range of solutions-based approaches to address societal challenges and sustainable development goals. Work is delivered through a range of working group modes: Strategy groups, Innovation and Evidence groups, Synthesis groups, underpinned by dedicated centre postdocs and seconded government scientists and a PhD training platform. Industry, Government and NGO partners contribute to formation of priorities and participate in working groups. Longer term physical infrastructure provides an opportunity for colocation of all sectors.

This critical mass of people with a comprehensive range of knowledge and expertise will be optimally placed to identify key questions that need to be solved. Co-design and co-delivery of solutions will be the model of operation. Working directly with the ultimate beneficiaries to shape the outcomes will greatly increase the uptake and ultimate impact of all the work we do.

As a first step, Queen's University has undertaken a leading role to bring together the core research centres across Ireland to form a climate and biodiversity network. This network links all major centres in climate change, energy and sustainability including social and political disciplines and will address the five keys areas of Climate Science, Climate Change Mitigation, Climate Change Adaptation, Biodiversity Change and Just Social Transitions.



Five key themes for the All-Island Climate and Biodiversity Research Network addressed by a range of solutions-based approaches in All-Island working groups.

The next stage of development seeks to establish projects combining academic expertise and capabilities to develop collaborative partnerships with government and industry. A challenge led, project pipeline of cross-disciplinary activities and proposals that will deliver to industry and communities across Northern Ireland is rapidly being established.

There are many opportunities to exploit the knowledge and research capability embodied in this approach and with our partners. A near-market example would be to dramatically increase the production of biogas optimally using agricultural waste to potentially:

- Displace natural gas from domestic homes or move a major part of our HGV fleet to biofuels (biogas or biodiesel)
- Substantially cut ammonia emissions from agriculture and greatly reduce excess nutrient pollution due to manure and digestate spreading leading to:
  - Improved air quality
  - Reduced greenhouse gas emissions
  - Healthier waterways and landscapes

Over the next decade we will need to know how climate change mitigation ideas such as afforestation, enhanced weathering, changing agricultural practise and adding bio-char to soils could work (or not) in the region. Equally, we need to monitor and improve biodiversity and reduce pollution. The most important and difficult task is displacing fossil fuels from transport and heating while reducing fuel poverty and creating globally competitive energy prices for industry. Research in partnership with industry, government and communities is essential if we are to solve these challenges and move to a zero-carbon future. Queen's aims to be the hub that enables and helps coordinate an NI response.

We already have a long history of working with DfE, providing advice, research and activities such as the current Energy strategy think pieces. Building on these foundations and links, we looking to build a strong and fruitful partnership with DfE and other NI government departments and would welcome further discussions on how to provide improved support and a stronger partnership into the future.

RECOMMENDATIONS:

- **Invest in essential support for future sustainable clean energy research, innovation, training and re-skilling**
- **Work in partnership with sustainability focused research centres and institutes to translate research into economic growth**

THE BRYDEN CENTRE

Interreg
EUROPEAN UNION
Northern Ireland - Ireland - Scotland
European Regional Development Fund

The Bryden Centre project is supported by the European Union's INTERREG VA Programme, managed by the Special EU Programmes Body (SEUPB

CASE
Centre For Advanced Sustainable Energy

Invest Northern Ireland

The Centre for Advanced Sustainable Energy (CASE) is funded through Invest NI's Competence Centre Programme and aims to transform the sustainable energy sector through business research.