Northern Ireland Electricity Networks

NETWORKS FOR NET ZERO

Delivering a sustainable energy system for all

ACKNOWLEDGEMENTS

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CONTENTS

FOREWORD

The twin challenges of re-building our economy after the Covid-19 pandemic, and transforming our society to achieve Net Zero carbon by 2050 provide the context for a unique period of change and opportunity in how we provide and consume energy in Northern Ireland. The Department for the Economy is currently leading the development of a new Energy Strategy for Northern Ireland and recently published a Consultation which seeks views on a comprehensive range of proposals under consideration to achieve a Vision of 'Net Zero Carbon and Affordable Energy'. In tandem with that, the Northern Ireland Assembly and the Executive are progressing consideration of Northern Ireland's first ever Climate Change Act.

The electricity network plays a critical role in making sure our economy and society has access to safe, secure and reliable energy in our homes, our farms, our schools and hospitals, and our businesses and other institutions. The electricity network has an equally important role to play in delivering the transition to Net Zero carbon by enabling more energy from renewable sources accessing the network and by enabling that energy being used by customers to replace fossil fuels in transport and heating. This opportunity to replace our dependency on imported fossil fuels with indigenous renewable energy supporting investment and jobs in Northern Ireland, is key to both economic recovery and to longer term climate action.

It is within that context that I am pleased to present Northern Ireland Electricity Networks' strategy report 'Networks for Net Zero'. This report sets out our considered views on the options and pathways for decarbonisation in Northern Ireland and how electrification can play a significant role in a flexible and integrated decarbonised energy system. It has customers at the core and assesses how customers will have increased opportunities for managing their energy demands more efficiently through adoption of new technologies and will have the ability to engage with new energy markets.

The report presents independent modelling that has been undertaken to examine the potential pathways to decarbonisation and presents inputs from academia who are engaged with studies and trials into many aspects of the low carbon transition. I would like to acknowledge the significant contributions from SONI Ltd, Queens University Belfast, Ulster University, University College Cork and Element Energy.

We set out how we can facilitate increased renewables on the network, how we can enable an increasing uptake of low carbon technologies such as electric vehicles, solar photovoltaics, electric heat pumps, and how we will support new technologies such as hydrogen electrolysis and battery storage, as well as the development and operation of new services and markets. We further set out how the role of NIE Networks as an organisation will change as a result - a journey to being a 'Distribution System Operator' that we have already commenced.

The specific pathway for Net Zero is complex and uncertain with many potential scenarios that may develop. What is certain is that it needs a coordinated approach from the Northern Ireland Executive, the Utility Regulator, energy industry participants, local councils, businesses, academia and consumer bodies to develop and deliver the most effective policies and solutions which minimise costs to customers. It is also clear that we need to move forward with greater resolve and make progress with existing proven technologies in those areas where this is most appropriate and commence projects on the ground which can also stimulate the economy in a post-pandemic 'Green Recovery'.

NIE Networks has a crucial role to play but we do not have all the answers. We are seeking your views and inputs to help inform how we progress on this journey and your feedback will assist us in our business planning process for our next Regulatory Price Control period which commences in 2024. So please engage and respond to the feedback section at the conclusion of the Report.

In presenting this strategy report, I hope that you find it informative and that it will assist and contribute to the wider debate on energy stimulated by the Department for the Economy's Energy Strategy Consultation.

Paul Stapleton
Managing Director, NIE Networks

Northern Ireland Electricity Networks

1. EXECUTIVE SUMMARY

1.1 NIE NETWORKS – AN OVERVIEW

NIE Networks is owned by ESB Group but operates as an independent organisation with its own Board and management teams and separate regulation via the Northern Ireland Authority for Utility Regulation *(or the Utility Regulator, as it is more commonly known)*.

- We own the electricity transmission and distribution networks in Northern Ireland, and operate the distribution system, transporting electricity to 895,000 customers;
- We invest over £100 million annually in maintaining and upgrading the electricity transmission and distribution infrastructure in Northern Ireland to ensure it remains in a safe and reliable condition;
- We contribute over £150 million annually to the Northern Ireland local economy;
- We directly employ over 1,200 highly skilled individuals and sustain hundreds of further jobs through our supply chain;
- We have delivered approximately 30% real price reduction in our network costs since privatisation; and
- We maintain a consistently strong financial performance managing an asset base of £1.6bn

Our role in the energy transition is to enable and facilitate the decarbonisation of energy production through accommodation of renewable generation, facilitate the uptake of low carbon technologies *(LCTs)* and through digitalisation develop and operate the network in an open and more efficient manner enabling customers to participate in new emerging markets. We don't produce or sell electricity, but are required to provide a connection for all sources of electricity, whether traditional or renewable generation and demand customers where requested. We are required to design and provide a network fit for purpose to enable this to happen and to achieve a zero-carbon society. In doing so we ensure that we continue to provide a safe and reliable network, whilst facilitating the delivery of this zero-carbon ambition in the most cost-effective way.

We welcome the commitments in the 'New Decade, New Approach[1]' Agreement to develop a strategy to tackle climate change, central to which is a new Northern Ireland energy strategy. In that regard we are also grateful for the opportunity to proactively engage in and support the Department for the Economy's *(DfE)* energy strategy process through engagement with other stakeholders in four of the Thematic Working Groups *(Power, Heat, Transport and Consumer)* assessing the options for a new energy strategy and the new Strategic Energy Framework for Northern Ireland for 2020-2030.

1.2 NORTHERN IRELAND'S CLIMATE CHANGE COMMITMENT

The 2015 Paris Agreement[2] has an objective of "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 above pre-industrial levels". In 2019, the European Green Deal[3] set out ambitious reduction levels for the European Union *(EU)* as a whole and aims to deliver Net Zero greenhouse gas[4] *(GHG)* emissions by 2050. In June 2019, the UK government announced a target of Net Zero GHG emissions by 2050[5] and in December 2020 the Committee on Climate Change *(CCC)* presented its 6th Carbon Budget on how the UK can deliver on this commitment.

Within the 6th Carbon Budget, the CCC has specifically outlined how Northern Ireland can meet its obligations as part of the UK effort and has recommended Northern Ireland reach an 82% reduction in GHG emissions by 2050 compared to 1990 levels excluding engineered greenhouse gas removals. In addition, Northern Ireland would be targeted to achieve Net Zero carbon dioxide (CO_2) emissions by 2050.

Northern Ireland's Executive has reinforced its climate change commitment in its 'New Decade, New Approach' agreement stating; "the Executive will introduce legislation and targets for reducing carbon emissions in line with the Paris Climate Change Accord". The Department for Agriculture, Environment and Rural Affairs *(DAERA)* is developing and consulting on a Climate Change bill for Northern Ireland. NIE Networks' considered opinion is that the bill should set interim emission reduction targets and a long-term target for Northern Ireland by 2050, where the long-term target represents an equitable contribution to achieving UK-wide Net Zero by 2050 as recommended in the CCC's 6th Carbon Budget.

NIE Networks advocates strongly for a strategy for Northern Ireland which aligns with the UK and European transitions. The first pillar of this must be **energy efficiency** as the most valuable unit of energy is the one not used. The challenge on energy efficiency for Northern Ireland cannot be underestimated with 90% of our homes being Energy Performance Certificate *(EPC)* Grade C or less. It is incumbent on policy makers to ensure our homes and premises are as energy efficient as possible and put the necessary financing mechanisms in place to address and support a comprehensive retrofit programme for Northern Ireland that stands the test of time. This will not be an insignificant amount of expenditure but it will have major positive impacts on home comfort and energy usage, especially in lower income housing. Coupled with this, better information on energy consumption through smart metering will empower customers to make more efficient decisions on energy usage. Northern Ireland requires to catch up with other developed countries in rolling out smart metering, as outlined in Chapter 9.

Secondly, **direct electrification** must be the next go-to strategy. With electricity consumption in Northern Ireland already 49.2% from renewable sources and a likely target of 70% for 2030, electrification is on a well-tested, proven technology pathway to fully decarbonising prior to 2050. There are unique opportunities for Northern Ireland to advance this strategy. The lesser reach of the gas network in Northern Ireland compared to Great Britain *(GB)* means electrification of heat should be a primary solution for well insulated new buildings and off gas grid customers. A strategy can be developed where electrifying heat in parallel with a rollout of an energy efficiency programme can be commenced as a matter of priority to make early progress and stimulate an emerging heat pump industry delivered with skill sets that exist within the region. In terms of the transport sector, with developments in battery technology and considering the geographic size of Northern Ireland, range anxiety is rapidly becoming less of a concern when making the decision to switch away from petrol or diesel vehicles. There has however, been limited progress in developing the necessary electric vehicle *(EV)* charging infrastructure and the remaining barriers to market entrants should be removed as a matter of priority.

Thirdly, utilisation of **other low carbon technologies** such as hydrogen, carbon capture and storage *(CCS)* and biogas should be progressed where technically and economically viable. Some of these technologies are less advanced in terms of commercial development and less proven from a technical and economic business perspective. There is a wide acceptance that there are specific sectoral uses for such low / zero carbon alternatives, for example the use of hydrogen in industrial processes, heavy transport and maritime applications, however a cautious approach should be adopted to fully understand the full costs and benefits of production and deployment. Hydrogen production and end use cases should be fully explored for Northern Ireland however we should recognise that in GB, the 2020s are expected to be a significant period of trial to fully understand the costs, risks and benefits from a production and end use perspective. Hydrogen is not yet a market-ready solution of scale, but it has the potential to play a significant role in decarbonisation in the longer term. Hydrogen should not be perceived as an alternative to, or in competition with, renewable electricity as a low carbon solution. Rather, both can be inter-dependent elements of an overall integrated clean energy strategy. In particular the longer-term potential for the production of hydrogen from renewable power, and its storage and use for industrial processes, transport and indeed power generation may be a significant element of the 2050 Net Zero energy system. However, scope for the safe and economic end use of hydrogen in the existing gas infrastructure is more uncertain and requires to be fully appraised. Until these detailed assessments are complete, further expansion of the gas grid should be viewed with caution and should be subject to detailed review as to whether it is in the best interests of the Northern Ireland customer in the long term.

1.3 CUSTOMER AT THE CENTRE

The climate change challenge will drive decarbonisation of society and the impacts of this will be profound and far reaching. The changes that are underway are already impacting on how customers are engaging with the electricity network with the past decade seeing an unprecedented uptake in customers installing renewable generation, a significant uptake of roof top solar photo-voltaic *(PV)* and the commencement of a switch to electric vehicles *(EVs)*.

Customers now have the opportunity to engage with LCTs and emerging energy markets to more efficiently manage their energy needs. This will further evolve over time and NIE Networks recognises that the needs of customers are wide ranging and different customers will seek to engage with the network and markets in different ways. Some will become active participants in the new world and others will remain passive relying on the network for meeting their electricity demands. Customers must be encouraged to engage with the energy markets through advice and information on options available to them and empowered to make the right decisions on how best to optimise their energy requirements. NIE Networks supports the formation of an independent advisory body to which we can contribute, to ensure relevant information is made available including how customers can avail of emerging flexibility services.

It is vital that the energy transition is fair in terms of sharing of benefits and costs and that the most vulnerable in society *(perhaps less able to actively participate)* benefit and are not unduly burdened with costs. NIE Networks is committed to ensuring information is available to the public, that network investments are incurred as efficiently as possible and tariffing arrangements are reviewed to ensure network costs are charged in a manner that is fair to all customers.

1.4 NETWORKS FOR NET ZERO

NIE Networks would concur with the widely adopted strategy in the UK, Europe and Ireland that electrification has a lead role to play in decarbonising key sectors which contribute to our GHG emissions. Central to facilitating this transition over the next three decades are the electricity networks and the role of the network owners and operators to ensure the transition can be met both technically and economically at minimal cost to the Northern Ireland customer.

The development of the electricity network needs to take account of the decarbonisation pathways for generation and demand, much of which is uncertain. To examine this uncertainty, NIE Networks engaged Element Energy to undertake an analysis into a range of possible scenarios across all sectors which could impact electricity production and consumption. On the generation side, a range of future renewable electricity consumption *(RES-E)* targets have been modelled *(60%, 70% and 80%)* together with ranges for uptake of solar PV and battery storage. On the demand side, ranges of uptake scenarios for transport through assessment of electric vehicle projections and domestic / commercial heating for high electrification and conversely high gas penetration scenarios were modelled. This work dove-tailed with the Transmission System Operator's *(SONI)* 'Tomorrows Energy Scenarios' to assess potential pathways on emissions reductions and impact on network costs.

These studies confirmed that with the right policy decisions, Northern Ireland can achieve its Net Zero commitments as outlined in the CCC's 6th Carbon Budget. Indeed, the power sector is capable of decarbonising ahead of 2050. The electrification of demand and moving away from fossil fuels in generation, heating and transport could reduce the demand on primary energy sources by as much as 48% by 2050 compared to today. This is because of the much greater energy efficiency of electricity compared with fossil fuels in areas such as transport and heat. It could also increase overall electricity consumption by between 50% and 70% by 2050.

The estimated combined distribution and transmission direct network costs over historic 'business as usual' network costs are assessed in the range of £525m - £700m by 2030 to achieve a renewable electricity target of at least 70%. NIE Networks has performed some high-level modelling to assess the impact of this increased investment on the cost of electricity given the expected increased usage of electricity arising from the electrification of heat and transport, estimated to be circa 19% by 2030. On average, network costs comprise 25% of domestic customers bills, assuming no other changes in pricing structure and taking this average bill composition, NIE Networks estimate that by 2025 and 2030 the charge to domestic customers relating to network costs will result in a 1% reduction in the overall cost they pay per unit of electricity consumed. The cost is dependent predominantly on the degree that off shore wind plays in the generation profile. NIE Networks would advocate the development of offshore wind as a solution given the opportunities Northern Ireland has for deployment of this technology to add to the diversity of generation mix. This would reduce the impact of accommodating this generation capacity on shore and the significant reinforcements to the distribution network this would necessitate.

1.5 SECTORAL CHALLENGES

For the power sector, NIE Networks would support the Economy Minister's assessment that the 2030 target for RES-E should be a minimum of 70% building on the significant progress achieved in Northern Ireland to date and exceeding the previous 2020 target of 40% ahead of schedule *(by 2019)*. In achieving the current level of 49.2%, investment was required to create additional capacity over the previously existing headroom and we are now at a point where the network is at capacity in many locations. Achieving 70% cannot be delivered with the same incremental approach previously adopted but will require significant strategic grid development to accommodate the predicted doubling of renewables required. Delivery of the second North South Interconnector will be a key enabler for the integration of additional renewable generation, addressing constraints on the transmission network, improving security of supply and allowing the grid to operate more effectively as part of an all-island Single Electricity Market (SEM). Offshore wind can play a significant role in the generation mix and any planning barriers to its development should be addressed. Greater system flexibility and in particular demand side management through flexibility arrangements for the Distribution System Operator *(DSO)* and Transmission System Operator *(TSO)* will enable greater efficiency of the electricity system to the benefit of all customers.

For the heat and building sectors, energy efficiency and low carbon heating options are inextricably linked. An early and immediate action is to align our Building Regulations for new homes to the Future Homes Standard in GB thereby ensuring a standard of construction which would facilitate the adoption of the most efficient low carbon heating option i.e. heat pumps. Alongside this, a comprehensive programme of building retrofits is required for Northern Ireland's poor housing stock, supported with appropriate funding mechanisms such as grants and low-cost finance. This would be a one-off investment which will have enduring energy efficiency improvements into the future. The adoption of hybrid heat pumps should also be progressed as they enable a very significant reduction in CO_2 emissions from home heating without the same level of investment in retrofit being required.

These measures would also have the effect of stimulating the local supply chain, which will be essential if Northern Ireland is going to meet its obligations in this sector and address the large number of customers who will be off gas grid or opt not to choose hydrogen *(if it proves to be an economic option and becomes available to them)*. Progressing an electrification strategy immediately can proceed in parallel with trialling alternatives to natural gas.

Northern Ireland should adopt the UK date for banning sales of new internal combustion engines in cars and vans and address the remaining barriers to the uptake of EVs by creating the right market conditions for electric vehicle charger providers. NIE Networks has advocated for the formation of a cross departmental taskforce including other stakeholders such as local councils, car suppliers and EV user groups to determine the most appropriate strategy for EV charger deployment between home, workplace and destination charging locations. Local government should also pursue all available funding routes from the UK Government to support provision of a local public charging infrastructure.

1.6 DELIVERING THE FUTURE

The delivery of the emerging targets for Northern Ireland will be challenging and will require a collective will and determination to remove all possible barriers. There is now a real sense of urgency to act on areas of least regret and make progress towards the 2030 ambitions. For NIE Networks, it is critical that the network cannot be a blocker to the transition but capacity must be available ahead of need. A change of thinking is required to make this happen through a fully coordinated joined up approach with collective action from the Northern Ireland Executive and Government Departments, the UK Government, Utility Regulator, and all industry participants.

The Northern Ireland Executive's Medium-Term Recovery Strategy published by the DfE in June 2020 recognises the "substantial economic recovery opportunity … to build a more competitive, inclusive and greener economy", and highlighted Clean Energy as one of the potential areas for growth. NIE Networks has identified eight tangible areas of opportunity to support the economy by unlocking investment in low carbon infrastructure and fast-tracking decarbonisation of heat and transport:

1. **Joining up policy and regulation to encourage investment**

   NIE Networks considers that the mandate of the Utility Regulator should be broadened to support decarbonisation and economic development. This would provide an opportunity to create a forward-looking regulatory framework that supports innovation and strategic investment, stimulating new employment opportunities and a more prosperous economy. NIE Networks additionally advocates a review of connection charging policies and regulations to align Northern Ireland with other neighbouring regions, making it an attractive and competitive place to invest. This review should ensure an appropriate method of charging is implemented and that connection costs are apportioned appropriately between the connectee and socialised costs whilst also taking into consideration customer willingness to pay and vulnerable customers.

2. **Accelerating investment in renewables**

   A new target of minimum 70% renewable electricity consumption will require a doubling of the current connected renewable capacity. Development of clear funding mechanisms will provide some certainty around market access and income streams to enable the investments to be economic for developers.

3. **Bringing forward network infrastructure investment**

   If the regulatory mandate permitted building network infrastructure ahead of need, this would enable advancement of least regret infrastructure projects. A new fast track approach would be required from the Utility Regulator and planning authorities to ensure projects can be delivered efficiently. Much of this investment will be regionally focused and will have a significant positive economic stimulus across all council areas in Northern Ireland.

4. **Improving the planning process**

   NIE Networks advocates a consistent and fast-tracked planning process implemented for 'green development' projects which prioritises the efficient delivery of low carbon and renewable projects with appropriate targets, timeframes and accountabilities.

5. **Low carbon transport**

   In the immediate term, developing an ultra-rapid charging hub infrastructure across Northern Ireland would have a significant impact in terms

of economic stimulus, due to the high upfront investment costs and promotion of the electric vehicle sector. NIE Networks has offered to kick start this infrastructure delivery if there is no viable market alternative.

6. **Digitalisation of the Energy System**

   NIE Networks advocates for the DfE to update the business case for implementation of smart metering and to initiate a trial of significant scale for smart meters as part of an integrated solution for customers using LCTs. In addition, NIE Networks advocates for further digital investment in the Northern Ireland electricity network and supporting infrastructure to enhance network visibility and controllability. Provision of data to customers, network operators and the wider market will provide greater empowerment and opportunity for more efficient operation of the network and more efficient management of customer demand.

7. **Building regulations**

   Supporting energy efficiency through the modernisation of building regulations is essential to align Northern Ireland's building regulations with those in GB and the RoI where progress towards near-zero carbon buildings has been made.

8. **Innovation**

   It is essential that we build on existing innovation activities in low carbon energy through increased government investment in areas such as large-scale trials of heat pumps, hybrid heating schemes, hydrogen electrolysis, smart metering, smart network technologies, energy storage and flexibility.

1.7 EVOLUTION OF NIE NETWORKS' ROLE

Through our four Sustainability pillars of 'Community', 'Environment', 'Workforce' and 'Future proofing' and being a signatory to the European Distribution System Operators *(E.DSO)* Sustainable Grid Charter, NIE Networks has committed to addressing its own business carbon footprint, ensuring the business has a minimal or positive impact on the local, national and global environment, community and economy. We will continue to support and facilitate the UK Net Zero targets, deliver our Sustainability Action Plan to achieve a business carbon footprint reduction of 12.5% *(against our 2019 baseline)* and embed sustainable practices within our everyday business operations.

The roles and responsibilities for distribution network owners / operators across the UK and Europe are evolving reflecting the most significant change on the distribution network in decades. NIE Networks will be required to manage a more complex, active distribution system which will have more dynamic generation, loading demands and flexible distributed energy resources. NIE Networks role is to act as a neutral facilitator to enable competitive access to markets and optimal use of energy resources on the network and provide the ability to maintain and operate the distribution system in the best possible way for all customers. The DSO pathway we have outlined to 2050 is NIE Networks assessment of the changes required to both the network and the organisation to facilitate this transition. This pathway presents a view on a range of enablers, namely network visibility, network controllability, customer and commercial development, market operability and systems and data development. The pathway to DSO will deliver whole system benefits and the success will be measured by the benefits it brings for customers.

NIE Networks is committed to playing its part in facilitating this energy transition on the pathway to a Net Zero future. As custodians of the electricity infrastructure we will build on our track record of efficient and successful delivery to ensure the network is developed in the safest, most efficient and cost reflective way as part of an overarching integrated energy strategy for Northern Ireland. We will ensure customers are at the centre of our strategy through ***engagement*** for information, education and consultation; through ***enablement*** ensuring the transition is open, transparent and as simple as possible; and through ***empowerment*** to ensure customers are confident to make real and informed choices and realise the benefits of a low carbon society.

NIE Networks does not have all the answers nor can it or should it operate in isolation. We are committed to ensuring our plans are part of a wider integrated 'whole system' approach and will continue to engage with local government, the Utility Regulator, electricity sector businesses, the other utility sectors, industry, commercial, retail and domestic customers to further the development of Northern Ireland's strategy.

1.8 IN SUMMARY

The decisions and actions we take over the next decade will fundamentally determine the progress Northern Ireland will make towards becoming a carbon free society. A Climate Change Bill for Northern Ireland and a new complementary Strategic Energy Framework to 2030 are long overdue but are essential to setting policy and direction for the various sectors against which integrated plans can be advanced with some degree of clarity. The emerging strategy for Northern Ireland requires to address:

- Coordination across government departments with timely complementary policies against a set of targets which align with our contribution to UK's Net Zero goals by 2050.
  - 82% reduction in GHG by 2050;
  - Net Zero CO_2 Emissions by 2050;
  - Net Zero power sector by 2050 with an aim to decarbonise earlier;
  - Set a minimum of 70% consumption of electricity from renewable energy by 2030 and promote a wide range of diverse renewable technologies including off shore wind.
- Progressing now where possible particularly in areas with proven technologies.
- Placing the customer at the forefront of the strategy in providing education, support to educate, enable and empower them to make the transition in as seamless and cost-effective way possible and provide protections for the vulnerable and fuel poor against unfair costs or lack of access to benefits of the transition.
- Energy efficiency first
  - promote energy efficiency and demand reduction through customer education and advice programmes;
  - consolidate the positive behaviours from the pandemic;
  - building retrofit programmes;
  - shift to public transport.
- Decarbonising heat
  - setting end dates for fossil fuel boilers in new homes;
  - promotion of low carbon heating *(heat pumps)* in new and off gas grid dwellings and commence this work now;
  - continue to investigate and trial alternatives to fossil fuels to fully understand the technical and economic case for deployment.
- Decarbonising transport
  - setting end dates for new petrol and diesel sales in Northern Ireland;
  - kick start the electric charging infrastructure industry that is urgently needed.
- Enhancing the regulatory framework
  - Broader remit for Utility Regulator to promote decarbonisation and economic development, ensuring a consistent framework to enable financeable and efficient regulated investment and promotion of appropriate market structures to attract capital in unregulated markets.
- Develop the skills and employment base in Northern Ireland
  - through STEM education programmes;
  - support for significant reskilling opportunities.

The next decade will be a time of change and adjustment as low carbon technologies become more commonplace. The way that people consider their energy demands will evolve as they move away from fossil fuel dependency for their heating and transport needs and develop the knowledge to become more energy efficient. There will be considerable opportunities to more actively engage with energy markets and utilise energy assets in a more efficient manner. Building on the considerable success to date with renewable generation, Northern Ireland will continue to increase its overall consumption from renewable sources as the power sector aims to decarbonise ahead of 2050. The network will require to be developed further to ensure adequate capacity for the increasing diverse mix of renewable technologies that will emerge.

NIE Networks has commenced its journey as a DSO and considers the pathway outlined in this report will ensure that the transmission and distribution networks and NIE Networks as an organisation are best positioned to facilitate the changes that will ensue over the next thirty years. We are embarking on what will be the most significant change to network design, management and operation since rural electrification in the 1960s and NIE Networks will evolve and enhance its capabilities and skills to facilitate this new world.

The transition to a DSO will deliver whole system and considerable customer benefits. NIE Networks intends to ensure that customers are at the centre of this transition and has engaged with stakeholders throughout this journey. The transition will not only benefit active customers through the facilitation of access to markets, but will also benefit all customers through minimising future network costs in the delivery of a low carbon economy.

Northern Ireland Electricity Networks

2. INTRODUCTION

CHAPTER 2 – INTRODUCTION

- **Climate Change Challenge** – This introduction summarises the Paris Agreement targets and legislative commitments to Net Zero in the United Kingdom and EU. The Committee on Climate Change's 6th Carbon Budget outlines the expectation for Northern Ireland to reach an 82% reduction in GHGs by 2050 compared to 1990 levels and to achieve Net Zero of CO_2 emissions by 2050. This should be reflected in the new Northern Ireland Climate Change Bill.
- **The Challenge for Northern Ireland** – The Power sector has led the way in decarbonisation in Northern Ireland with 49.2% of electricity consumption derived from indigenous renewable sources and exceeding the previous SEF target of 40% by 2020 one year early. NIE Networks considers that the Power sector could be one of the first to decarbonise and that targets should consider a renewable consumption figure of minimum 70% and a diverse primary energy source mix including offshore wind production.
- NIE Networks supports the need for delivery of the second North South Interconnector. This investment is of strategic importance to Northern Ireland and will: *(a)* support economic growth and *(b)* facilitate the connection of more renewable generation.
- Electricity demand is expected to almost double but demand shifting techniques and flexibility services are expected to provide the ability to optimise infrastructure reinforcement.
- **Heat** – Government must produce a Heat and Buildings strategy which addresses the phase-out of fossil fuel heating and the rebalancing of policy costs between electricity and gas. Consideration must be given to updating the Building Regulations and the promotion of low carbon alternatives. There is potential for repurposing the gas network away from natural gas. However, the technology and economics for a mass heat rollout application need to be trialled and developed through the 2020s. Electrification through developed products such as heat pumps can provide an extremely efficient heating solution albeit the industry in Northern Ireland is not as developed as elsewhere in GB and RoI.
- **Transport** – The uptake of electric vehicles in Northern Ireland to date has been slow and somewhat hindered by the lack of an extensive charging network and lack of market entrants. An overall charging infrastructure strategy is required which will attract new entrants and encourage the switch to EVs.
- **Energy Strategy** – NIE Networks has been proactively engaging with stakeholders in the development of energy strategy and believes a customer centric approach is essential. The outworking of policy must consider the impact on costs and be balanced across current and future generations. It is vital that vulnerable customers are protected from unequal cost burden but must also share in the benefits of a zero-carbon society.
- **Green Recovery** – The required investment for Net Zero could support the UK's and Northern Ireland's economic recovery post-pandemic by 'building back better' using green technologies.
- **Sense of Urgency** – Many steps can be taken with confidence in the next decade and should begin immediately. There are policy, regulatory and strategy directions that require urgent resolution but key is a coordinated approach from policy makers.

2.1 CLIMATE CHANGE CHALLENGE

2.1.1 The Global Policy Context

It is now well understood that climate change is a global problem requiring a global response. The Intergovernmental Panel on Climate Change *(IPCC)* concluded that it was unequivocal that humans were influencing the climate. The 2015 Paris Agreement has an objective of "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 above pre-industrial levels"[7]. It aims to achieve this objective by requiring bottom-up nationally determined contributions from each country that reflect their particular circumstances and capabilities.

The increase in global temperature is determined mainly by total CO_2 emissions over time, which must fall to near zero in order to limit global warming. The UK CCC states[8] that today's level of warming is already having significant impacts around the world. The frequency of heatwaves has increased in most land regions[9]. There are demonstrable impacts on heat-related mortality particularly for elderly and vulnerable people[10]. Patterns of water availability are changing due to melting land-ice and shifting rainfall in some parts of the world. Flooding is also increasing in coastal areas as climate change pushes up sea-levels. Climate change is being increasingly linked with making the conditions for wildfires more likely[11] and has also affected crop yields, with more negative than positive effects[12].

Rapid and sustained reductions in GHG emissions will be needed over several decades to keep additional warming within the limits of the Paris Agreement.

2.1.2 European Context

EU legislation generally takes a long-term view on climate and energy policy. As early as 2011, the 2050 Low Carbon Economy Roadmap demonstrated that it was feasible and affordable for the EU to reduce domestic emissions by 80% by 2050 compared to 1990 with a milestone of a 40% reduction by 2030 which is reflected in the current UK Climate Change Act requirement.

On 28 November 2018, the EU Commission presented its strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050. Within the Strategy, the EU confirmed that a minimum reduction of 80% of GHG emissions[13] would be consistent with the Paris Agreement objectives of reducing forecast global emissions to well below 2°C and that they can be achieved efficiently.

A new European Commission introduced the European Green Deal at the end of 2019, clearly setting out more ambitious reduction levels for the EU as a whole and aiming to deliver Net Zero GHG emissions by 2050 and to increase the GHG emissions reduction target from 40% to 55% by 2030[14].

In November 2019, the Sustainable Grid Charter was published. The purpose of the charter is to encourage policymakers and investors as well as DSOs to pursue sustainability in all its forms in the electricity distribution industry.

The E.DSO and its members *(including NIE Networks)* stated their commitment to sustainability with regard not only to climate and environmental issues but also to social and governmental issues both now and in the future.

The World Energy Investment Outlook *(2014)* Report has estimated that between 2014 and 2035, the EU will need to invest a total of 650 billion USD into electricity grids to meet its decarbonisation targets, 75% of this expenditure is in distribution networks to which the majority of Renewable Energy Sources *(RES)* are connected. Without appropriate investments in electricity networks the energy transition will not happen[15].

2.1.3 United Kingdom Context

In June 2019, the UK government announced a UK target of Net Zero GHG emissions by 2050 following recommendations made by the CCC[16]. This change to legislation came into force on 27 June 2019 and amended the Climate Change Act 2008 target of an 80% reduction in GHG emissions compared with the 1990 levels.

In the last three decades, UK GHG emissions have fallen at an average rate of 13 $MtCO_2e$ *(Metric tons of carbon dioxide equivalent)* per year which equates to a 40% reduction. Outside of the electricity supply sector, emissions have fallen at an average rate of just 7 $MtCO_2e$ per year. Progress has been quicker in recent years, primarily led by the UK's transition from coal-fired power generation towards low-carbon generation. Although in the last five years emissions have fallen by 16 $MtCO_2e$ on average, they must fall at a faster rate to meet the 6th Carbon Budget *(by around 21 $MtCO_2e$ per year).* However, the power sector can no longer be relied upon to deliver the majority of these reductions; progress must extend to all sectors of the economy[17].

Momentum in the UK is building towards the UK's Net Zero objective. 80% of the public are

concerned about climate change and 66% of people are now aware of Net Zero specifically, up from around 50% earlier in 2020[18].

The CCC has created and analysed five different scenarios within the 6th Carbon Budget. These options are to confirm the level of ambition required across different sectors and are listed below:

- Headwinds Pathway;
- Widespread Engagement Pathway;
- Widespread Innovation Pathway;
- Tailwinds Pathway;
- Balanced Net Zero Pathway.

Each of the pathways can be studied further in the CCC's 6th Carbon Report. However, the report concludes that due to the relatively balanced mix of contributions from demand-side action, electrification, hydrogen and GHG removals, the 'Balanced Net Zero Pathway' provides the best balance between level of ambition and meeting the Net Zero target. This pathway places the UK in line with the most ambitious commitments for 2030 compared to similar countries also targeting Net Zero by 2050[19] and leaves the UK well-placed to support raising international ambition as the host of COP26[20] and President of the G7[21].

2.1.4 Ireland Context

As a member of the EU, the Irish Government developed its National Energy and Climate Plan *(NECP)* required by Article 15 of EU Regulation *(EU)* 2018/1999, then subsequently published its Climate Action Plan in 2019.

The key features of the plan include:

- a five-year Carbon Budget and sectoral targets with a detailed plan of actions to deliver them;
- formation of a Climate Action Delivery Board overseen by the Department of the Taoiseach to ensure delivery;
- formation of an independent Climate Action Council to recommend the Carbon Budget and evaluate policy with strong accountability to an Oireachtas Climate Action Committee; and
- carbon proofing all Government decisions and major investments.

The 2019 Climate Action Plan is presently under review to reflect higher commitments by significantly increasing or advancing original targets.

2.1.5 Northern Ireland Context

Northern Ireland does not currently have climate change legislation separate to the UK, however its New Decade, New Approach agreement announced in January 2020 states; 'the Executive will introduce legislation and targets for reducing carbon emissions in line with the Paris Climate Change Accord'[22]. GHG emissions from Northern Ireland contribute to the UK total under the Climate Change Act 2008, meaning deep emissions reductions in Northern Ireland are crucial if the UK is to meet its obligations under the Paris Agreement.

Northern Ireland has devolved responsibility for energy policy, excluding nuclear energy and carbon capture and storage *(CCS)* which are covered at a national level. Since November 2007, the electricity industry has been operating in the Single Electricity Market *(SEM)* – a single wholesale market across the Island of Ireland. Northern Ireland is a joint member of the all-island Integrated Single Electricity Market *(I-SEM)* shared with the RoI which went live in October 2018[23]. The primary aims of the market are to:

- integrate the all-island market with the European Internal Energy Market;
- increase opportunities to trade in different time frames; and
- to increase the efficiency of cross-border interconnectors.

The nature of the all-island market means that any energy policies in Northern Ireland that affect the supply-side of energy must be compatible with RoI policy, and vice-versa, in order to avoid market distortions that incentivise inefficient generation.

In the CCC's 'Balanced Net Zero' Pathway, Northern Ireland is expected to reach an 82% reduction in GHGs by 2050 compared to 1990 levels, excluding engineered greenhouse gas removals[24]. As a sub category of all GHG's, Northern Ireland is expected to achieve Net Zero of CO_2 emissions by 2050 due to the long lasting impacts this gas creates[25]. This glide path to meet these targets is visualised in Figure 1.

The CCC 6th Carbon Budget expects that some parts of the UK will be 'net sources' of GHGs by 2050 with emissions offset in other parts of the UK that are 'net sinks'.

Northern Ireland is a significant net exporter of agri-food products with nearly 50% of all agri-food products produced in Northern Ireland consumed in the rest of the UK. Around 10% of all UK emissions are from agriculture, compared

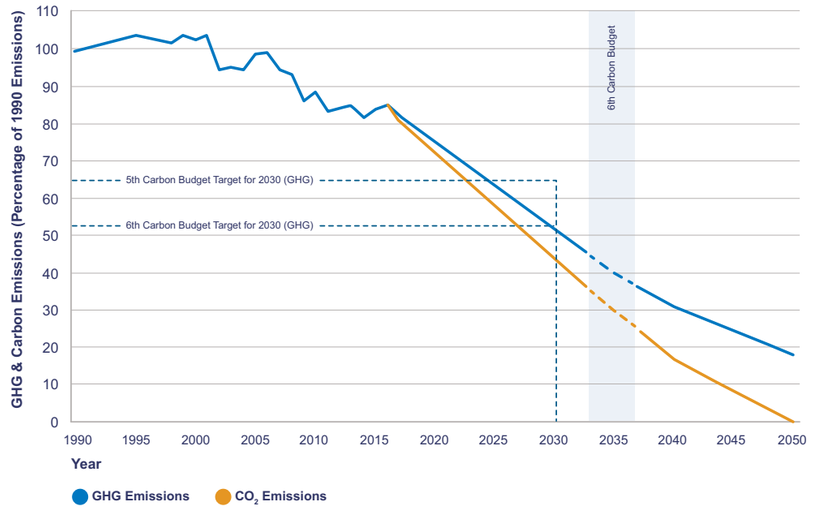


Figure 1 – Glide Path for Northern Ireland GHG & CO2 Emissions by 2050

to 27% in Northern Ireland[26]. There is no purely technical reason why Net Zero is not possible in Northern Ireland. However, Net Zero GHGs in Northern Ireland would mean a substantial reduction in output from Northern Ireland's livestock farming sector or *(possibly and)* much greater than equal share of all UK GHG removals being located in Northern Ireland compared to its current emissions, population or economic output[27]. The CCC suggests it is therefore fair that, as well as taking the right actions to reduce emissions from agriculture, some of these emissions should be offset by 'sinks' that are located elsewhere in the UK[28].

DAERA is presently consulting on a Climate Change Bill for Northern Ireland. NIE Networks would support the bill setting interim emission reduction targets and a long-term target for Northern Ireland by 2050, that will represent an equitable contribution to achieving UK-wide Net Zero by 2050 as recommended in the CCC's 6th Carbon Budget.

Northern Ireland accounted for 4.3% of UK GHG emissions in 2018[29] and its GHG emissions have been reducing, with the latest emission statistics published in June 2020 confirming a decrease of 2.5% in 2018 compared with 2017 to 19.4 $MtCO_2e$. The longer-term trend indicates a decrease of 20% in Northern Ireland's greenhouse gas emissions compared to the base year *(1990)*. The largest sectors in terms of emissions in 2018 were agriculture *(27%)*; transport *(23%)* and energy supply *(15%)* as shown in Figure 2 below. Most sectors showed a decreasing trend since the base year.

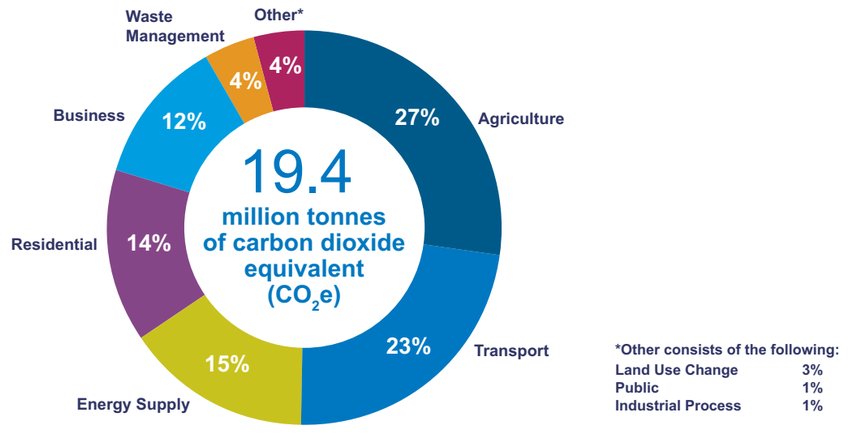


Figure 2 –Sectoral Breakdown of Northern Ireland's 2018 Greenhouse Gas Emissions

2.2 THE CHALLENGE FOR NORTHERN IRELAND

Table 1 below summarises the suggested targets set out in Section 2.1.5 above for Northern Ireland:[30]

Time Period	Reduction in all GHG Emissions Compared to 1990 Levels	Reduction in CO_2 Emissions Compared to 1990 Levels
2030	48%	56%
Average over UK 6th Carbon Budget Period *(2033-2037)*	60%	70%
2040	69%	83%
2050	82%	Net Zero

Table 1 - Intermediate Emissions Reduction Targets for Northern Ireland

2.2.1 Power Sector

In 2010 the Strategic Energy Framework *(SEF)* for Northern Ireland set an ambitious target for 40% of demand to be met by Renewable Energy Sources for Electricity *(RES-E)*. Northern Ireland was successful in achieving this target objective one year in advance of the 2020 target.

The percentage of total electricity consumption generated from indigenous renewable sources, as a twelve-month rolling average, is illustrated below. For the 12-month period January 2020 to December 2020[31] this totalled 49.2% of total electricity consumption.

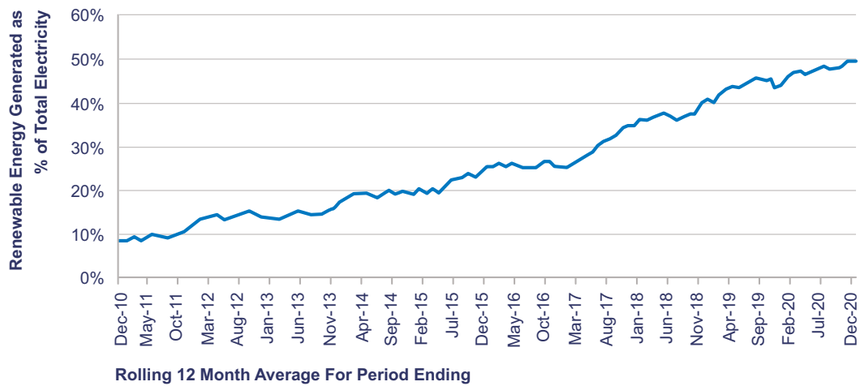


Figure 3 - Rolling 12 Month Average from December 2010 to December 2020

Since the publication of the SEF 2010-2020, the volume of renewable generation grew from approximately 450MW to 1,700MW.

The technology mix of connected renewable generation in Northern Ireland as of end Q4 2020 is shown in Figure 4 below, with wind being the major contributor of 1280MW. There is also a further 343MW of renewable generation technology committed to be connected to the network.

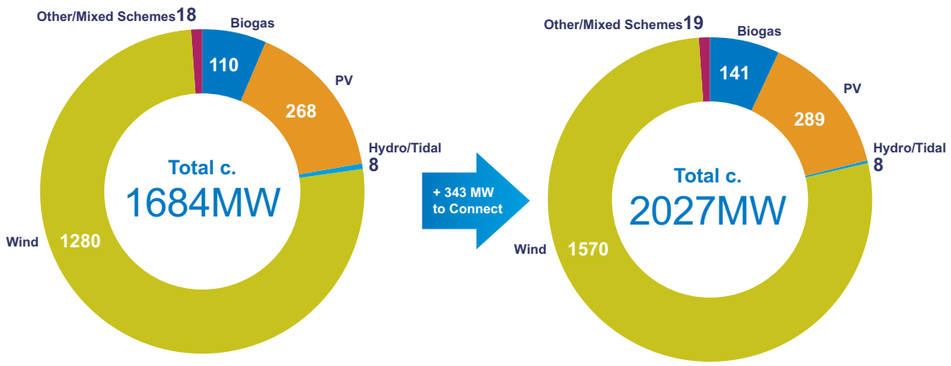


Figure 4 – Northern Ireland Connected Renewable Generation Technology Mix

The DfE which is responsible for energy policy is in the process of developing the next SEF 2020-2030, with the Energy Strategy consultation released on the 31st March 2021 and the final SEF due in November 2021. This policy will create a roadmap to the 2030 ambitions and will require a transformational change to the transmission and distribution systems in a number of different policy areas. Promising levels of ambition for this new SEF are emerging, as the Economy Minister has recently stated that a supportive policy environment is needed to deliver these Net Zero investments and that whilst work is ongoing, evidence should be gathered to set the new target. Initial considerations are that the 2030 target should not be below 70 per cent[32]. This would be consistent with ambition levels in the RoI.

Generation

The National Infrastructure Strategy *(NIS)* states that the UK has committed to ending coal electricity generation no later than 2025. The CCC's 'Balanced Net Zero' Pathway proposes to decarbonise electricity generation completely by 2035, with action thereafter focused on meeting new demands in a low-carbon way[33]. This would mean no new unabated[34] gas plants should be built after 2030, and the burning of unabated natural gas for electricity generation should aim to be phased out entirely by 2035. Any gas plant built before 2030 should be made ready for a switch to CCS.

For Northern Ireland, NIE Networks considers that the Power sector could be one of the first to decarbonise. Targets in the SEF should consider not just a renewable consumption figure but also an assessment of the primary energy source mix most optimal for Northern Ireland including offshore wind production.

Figure 5[35] below provides an overview of the technology options and potential mix based on the assumptions derived from the Element Energy and TSO's Tomorrows Energy Scenario Northern Ireland *(TESNI)* processes. There is a broad range of technologies that can be offered into the market including offshore wind, marine tidal energy, carbon capture and storage.

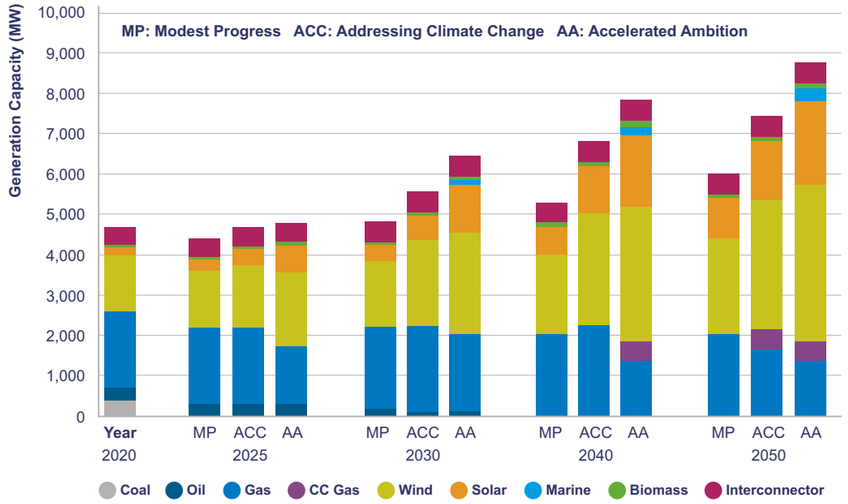


Figure 5 – Possible Generation Mix by Year depending on Progress

Figure 6 below illustrates the levelised cost estimates for generation projects commissioning in 2025, 2030, 2035 and 2040[36]. In line with Figure 5, which highlights a significant increase in renewable technology out to 2050, the commissioning of new renewable generation will become economically advantageous, as the cost of renewable generation is projected to continually decrease. In comparison, alternative generation methods such as Combined Cycle Gas Turbines are projected to increase in cost, reaching a 47% increase from 2025 to 2040.

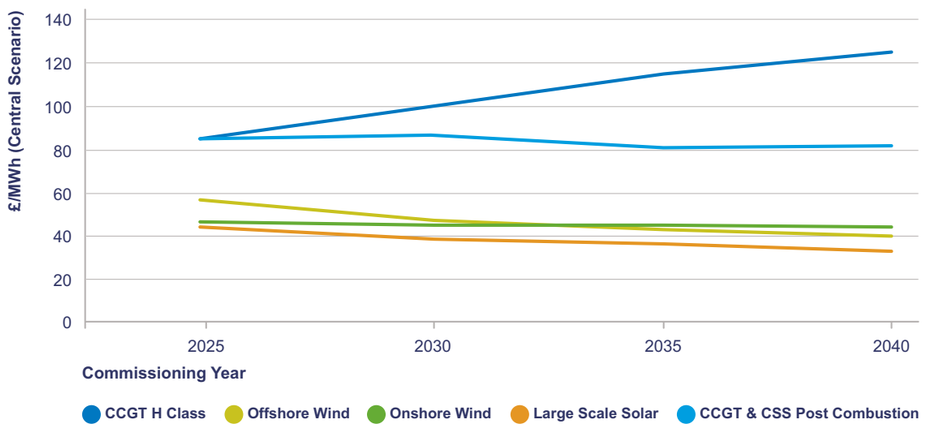


Figure 6 - Comparison Between Generation Technologies Over Time

Interconnection

Northern Ireland currently has interconnection with the RoI and Scotland. The interconnection with the Irish transmission system enables the power system to be operated on an all-island basis. The Greenlink Interconnector between RoI and Wales and the development of the Celtic interconnector between France and RoI *(due to energise in 2026)* will provide market participants greater access to the wider European market, helping to suppress wholesale electricity prices, reducing renewable electricity constraints and enhancing security of supply. For Northern Ireland customers to benefit from the increasing levels of interconnection into Ireland, it is essential that the second North South Interconnector is constructed and commissioned.

This investment is of strategic importance to Northern Ireland and in addition to the benefits set out above will support economic growth in Northern Ireland and will facilitate the connection of more renewable generation to the network.

The project is needed because at present although the electricity transmission network operates on an all-island basis, there is currently only one 275kV interconnector linking North and South. This restricts the amount of electricity that can flow between the two networks.

Demand

Electricity consumption in Northern Ireland peaks during the winter months and is at its lowest during the summer months. Total consumption in 2020 was 8.9 Terawatt hours *(TWh)*[37] and is forecast to potentially reach 15.7TWh by 2050. This increase in demand is expected as other sectors transform to low carbon alternatives such as EVs and low carbon electric heating such as heat pumps[38]. The potential for green hydrogen production in Northern Ireland through electrolysis could create a further increase in electrical demand.

Even though the demand is expected to almost double, demand shifting techniques such as pre-heating in buildings, storage availability, smart vehicle charging and decision making informed by smart metering[39] are expected to provide flexibility and ensure optimisation of infrastructure reinforcement[40].

One such example of a demand shift technique is NIE Networks' first ever Flexibility tender. This tender offers customers opportunities to support their local distribution networks by being flexible with their electricity consumption or generation, earning revenues in return.

Customers, or aggregators operating on their behalf, will be scheduled or signalled to flex their assets so that NIE Networks can analyse the response and network impact in Flexibility Trial Zones *(FTZs)*. The FTZs in this tender are distributed across Northern Ireland covering 15% of all customers.

If the trial is successful, Flexibility could be used to manage emerging network congestion in future regulatory periods[41]. To enable further development of such techniques, digitalisation of current electricity meters and a review of tariff structure is required. This is outlined further in Chapter 6.

Storage

Storage that will capture surplus energy when demand is low and provide backup generation when demand is particularly high will be required to extract maximum benefit from the ever-increasing share of variable renewables.

The CCC's Balanced Pathway scenario expects batteries to provide within-day flexibility to offer services to the energy system at short notice and assumes 18 Gigawatt of battery storage capacity across the UK by 2035, highlighting its importance in the future energy system[42].

The CCC's Balanced Pathway scenario uses hydrogen as the primary source of storage for power generation. Surplus electricity generation could potentially be used for electrolysers to produce hydrogen subject to favourable economic appraisal. In the Balanced Pathway scenario, 25% of hydrogen supply comes from electrolysis in 2035, increasing to 45% by 2050.

The UK Government's Hydrogen Strategy is due to be published in spring 2021. It will set out a vision for hydrogen's role in meeting Net Zero in the longer term, together with the actions, regulations and incentives across end-use applications and supply to develop hydrogen's role over the next decade[43]. Regardless of the outcome of this strategy it should not restrict the general direction of travel of increasing RES-E and in preparing for the associated infrastructure investment now.

Regulatory Issues

Overall, policy must tackle both the demand-side and supply-side for low carbon products and ensure relevant infrastructure is available when needed. This will require network infrastructure to be built ahead of the time of need so it can act as an enabler to the decarbonisation targets. It is vitally important that network constraints should not become a blocker to the transition. The cost

of upgrading the distribution network capacity is relatively insensitive to the size of the capacity increase, as most of the cost is in the civil works rather than the equipment *(e.g. larger cables)*. Building in additional capacity at the connection / reinforcement stage will result in customer cost savings as the counterfactual retrospective costs would be higher. By future-proofing the networks, the costs can be limited and avoid creating a blocker or the requirement to increase the capacity again prior to 2050[44]. This approach would require policy commitment from the Utility Regulator.

The UK government supports the National Infrastructure Commission's *(NIC)* recommendation that, where relevant, regulators should have duties to support Net Zero targets. The government will continue to review the most appropriate measures, including a Net Zero duty, to ensure that regulators make the necessary contributions to achieve these targets. NIE Networks would advocate for the NIC's recommendations to be applied to regulation in Northern Ireland.

This would enable the Utility Regulator to consider decarbonisation and economic objectives while providing an opportunity to create a forward-looking regulatory framework that supports innovation and strategic investment.

2.2.2 Heat

As of April 2019, 68% of household central heating systems are oil fired compared to 24% with gas central heating and 8% other central heating including solid fuel, electric and dual fuel systems, as illustrated in Figure 7 below.

Currently, there is no specific mechanism for supporting low-carbon heat in residential buildings, non-residential buildings or industry in Northern Ireland, although funding can be obtained as part of certain energy efficiency schemes[45].

Government must produce a robust and ambitious Heat and Buildings strategy which sets the direction for the next decade, with clear signals on the phase-out of fossil heating, rebalancing of policy costs between electricity and gas with commitments to funding and delivery plans. Part of such a policy should investigate equivalent initiatives not currently present in Northern Ireland, but available in the rest of the UK.

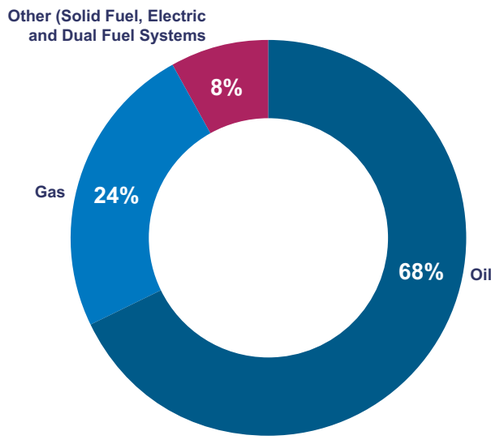


Figure 7 – Percentage of House Heating Systems by Fuel

Building Regulations

Meeting the earliest possible date for Net Zero emissions will require major improvements to the energy efficiency of new and existing buildings in order to improve comfort levels, lower energy bills and prepare the building stock for a switch to low-carbon heating[46].

The CCC's Balanced Pathway is underpinned by a clear timetable for standards to make all buildings energy efficient and ultimately low-carbon, for example, all rented homes should achieve EPC C by 2028 in line with new Government proposals and social homes aligned to the same timetable[47]. Proper enforcement of standards and an effective approach to skills availability are essential.

There are a number of UK initiatives not currently present in Northern Ireland. These include funding to make homes and buildings greener and more energy efficient through the Green Homes Grant, a Public Sector Decarbonisation Scheme and a Social Housing Decarbonisation Fund demonstrator.

The Energy White paper published by the UK Government in December 2020 proposes to support the lowest paid households with their bills through a £6.7 billion package of measures which could save families in old inefficient homes up to £400 annually. This includes extending the Warm Home Discount Scheme to 2026 to cover an extra 750,000 households and giving eligible households £150 off their electricity bills each winter. The Green Homes Grant announced by the Chancellor has been provided with £1 billion to extend the scheme for a further year as part of the Ten Point Plan. These measures do not currently apply to Northern Ireland. Northern Ireland requires a full range of similar funding options to implement energy efficiency measures covering social, rented and owned properties.

Low Carbon Alternatives

Boiler lifetimes of fifteen years imply a phase-out date for the installation of fossil fuel boilers in advance of 2035. This is required for the uptake of low-carbon heat to be sufficient to decarbonise buildings by 2050. The CCC's Balanced Pathway predicts sales of oil boilers to be phased out by 2028, and gas boilers by 2033 in residential homes, with the exception of hydrogen-ready gas boilers in areas where the gas grid is set to convert to low-carbon hydrogen[48].

With this in mind, there is a need to rapidly scale up supply chains for heat pumps and heat networks and to explore options of hydrogen for heat. In this regard there is a substantial trials programme envisaged in GB which will assess the viability for hydrogen deployment. The view of the CCC in the Balanced Pathways is that 11% of homes would be heated using hydrogen and in particular zones close to industry.

Even though the gas network is much less developed in Northern Ireland, it is relatively new and modern, consisting primarily of polyethylene pipe. Circa 30% of households were connected to the gas grid by September 2020 *(although this is increasing)*, compared to 87% for the UK as a whole. Of the total connections to the gas network, 81% are in the Greater Belfast area and the remaining 15% in the Ten Towns area[49].

The CCC suggests properties located off the gas grid in Northern Ireland are likely to go straight to low-carbon heating rather than connect to the gas grid[50]. As such it is important that conditions are right to encourage the uptake of retrofit programmes and heat pump installations to create the supply chains and develop the markets for this technology which has been proven in many countries across the world.

With regards to a low carbon alternative to natural gas, hydrogen trials are to scale up rapidly in the 2020s to enable rapid grid conversion from 2030 onwards as detailed in the CCC's Policy report[51].

According to the NIS the UK government is establishing a £240 million Net Zero Hydrogen Fund to realise the potential of hydrogen. This will provide capital funding to support deployment of low-carbon hydrogen production in the UK, and will support both methane reformation with Carbon Capture and Storage *(CCS) ('blue' hydrogen)*, and electrolysis using renewable electricity *('green' hydrogen)*. Working alongside partners in industry, the government's aim is for the UK to develop 5GW of low carbon hydrogen production capacity by 2030, with a mixture of 'blue' and 'green' hydrogen. How exactly hydrogen should be utilised is expected to be outlined in the UK's Hydrogen Strategy 2021. Once this report is published, NIE Networks would recommend the findings are re-evaluated considering the vast difference in gas infrastructure within Northern Ireland compared to the rest of GB.

The heating sector uses around 50% of final use energy demand and while there are a number of options under consideration, one of which includes electrification, creating a Net Zero heating sector is a major challenge. There are already technologies and solutions for the decarbonisation of the electricity sector that have been tried and tested that should be progressed.

Solutions for high temperature processes in the long-term that would be difficult through electrification could provide opportunities for the gas and oil sectors as these technologies emerge.

Energy efficiency is a key element in decarbonisation of heat, whether via use of electrification or decarbonised gas for heating.

2.2.3 Transport

In 2016, there were 1.13 million vehicles licensed in Northern Ireland. The transport sector in Northern Ireland is dominated by passenger car vehicles. Approximately 61% of all licensed vehicles are fuelled by diesel, 39% by petrol and less than 1% by other types of fuel. Overall, approximately 76% of all petrol and diesel fuel consumed for road transport purposes in Northern Ireland was for personal use with 24% used by freight[52].

In line with the UK's position on banning of petrol and diesel internal combustion engines *(ICEs)*, new petrol and diesel cars and vans will not be sold after 2030. Between 2030 and 2035, any new cars and vans sold with tailpipe emissions should be capable of driving a significant distance with no carbon emissions from the tailpipe. All cars and vans sold after 2035 will be fully zero emissions at the tailpipe.

Electric Vehicles

The current level of electric vehicles in Northern Ireland is just over 4000 as of September 2020[53], with only 337 public charging points installed. The Transport Infrastructure Roadmap[54] which was produced by the Low Carbon Vehicle Partnership estimated that an appropriate number of recharging points should be equivalent to one charging point per ten cars *(subject to other considerations)*. By that logic Northern Ireland should presently have 400 charge points if there are an estimated 4000 EVs in Northern Ireland. By 2023 the UK government expects to see a high-powered charging hub at every motorway service area, installed by the private sector. This is backed up by investment of £950 million in future proofing grid capacity along motorways and key 'A' roads to prepare for a 100% uptake of zero emission cars and vans ahead of need.

A similar approach is required in Northern Ireland where currently the low level of public charging infrastructure is a significant barrier to the uptake of electric vehicles. The Committee on Climate Change estimate that Northern Ireland may require between 30 to 35 public rapid chargers on major roads and 800 to 950 public top-up chargers by 2050, while other research performed by Deloitte[55] suggests that fast and rapid charging infrastructure at the kerbside, destinations, urban charging hubs and motorway service areas could cope with an EV charge point ratio of 500:1 by 2030 which is the same rate as petrol pumps per car. Northern Ireland has around 1.2 million licenced vehicles on the road as of the end of 2020. If a ratio of 500:1 is applied, 2400 charge points would be required to cover the whole of Northern Ireland. Regardless of the variation in the exact amount of charge points required, it is clear that a significant increase is required. The UK government is also extending support for charge point installation at homes, workplaces and on-street locations.

Furthermore, consideration could be given to a tax system that will encourage the uptake of EVs and that revenue from motoring taxes could be used to keep pace with the level of ambition.

Recently the Utility Regulator added an exclusion to the Maximum Retail Price *(MRP)* for the resale of electricity where it relates to the propulsion of an Ultra-Low Emission Vehicle *(ULEV)*. The MRP sets the maximum price that a customer should expect to pay for electricity provided by an authorised supplier. This change ensures electricity resold for use in the propulsion of an ULEV will not be a barrier to the development or maintenance of ULEV public infrastructure *(and therefore also the uptake of ULEV's)*. This change in direction was applied from the 23 March 2020[56].

Another promising proposal by the Infrastructure Minister is to change planning rules to permit certain types of development to take place without the need for planning permission. Among these proposals is recharging infrastructure for electric vehicles[57].

The National Infrastructure Strategy *(NIS)* is committing to invest £1.3 billion in charging infrastructure to accelerate the mass adoption of EVs ahead of ending the sale of new petrol and diesel cars by 2030. A proportionate funding approach is required in Northern Ireland, while ensuring that charging infrastructure is simple and consistent in terms of payment options.

Demand-Side Transport Measures

Devolved administrations must implement effective policies to make it easy for people to walk, cycle and use low-carbon public transport[58]. Northern Ireland has an ambition for 40% of all journeys less than one mile, 20% of journeys between one and two miles and 10% of journeys between two and five miles to be cycled by 2040. Additionally, transport demands could be significantly reduced through video-conferencing and augmented reality technologies.

A comprehensive policy package will be needed to deliver on the Government's new commitment to phase out new sales of petrol and diesel cars and vans by 2030, including ensuring that plug-in hybrids play no more than a niche role by then. A further commitment should be made to phase out sales of diesel HGVs by no later than 2040, supported by large-scale trials in the near term. Recharging and refuelling infrastructure will need to develop to meet the range of emerging needs. Effective demand-side policy is also essential. The CCC has identified significant opportunities and advantages to reducing travel demand, but this will not happen without firm policies encouraging shifts to walking, cycling and public transport[59].

2.3 NIE Networks and Northern Ireland Energy Strategy

The 6th Carbon Budget states the UK's commitment to Net Zero GHG emissions by 2050 will be transformational across all sectors including the electricity supply industry. There will be sweeping changes across the energy system, in terms of the way we trade electricity, the way customers engage with energy consumption and the way that the electricity grid is developed and planned. There are significant challenges associated with this level of change, but equally there are significant opportunities for Northern Ireland.

As a result of the level of the anticipated change required, NIE Networks has been proactively engaging with stakeholders in the development of energy strategy in Northern Ireland.

2.3.1 Engagement

- NIE Networks hosted an event in Stormont at the start of 2020 to highlight the importance of collaborative engagement with all stakeholders to meet the challenges of decarbonisation. The main aim was to demonstrate that this could not be done by one company or sector, but will need a range of stakeholders empowered by policy across different government departments to achieve our goal.
- In March 2020, NIE Networks undertook an extensive exercise across the entire business to collate a detailed response to the DfE's call for evidence on the next SEF. Within that response NIE Networks presented views on metering, tariffs, connection policies, fuel poverty, energy efficiency, heat, power, transport, security of supply, data requirements and economic opportunities. NIE Networks are also now members of the SEF's Power, Heat, Transport and Consumer Working Groups to offer further guidance and information as required.
- NIE Networks are actively engaged in the Energy Networks Association *(ENA)* working groups to ensure we stay up to date with energy sector developments and we monitor associated climate change reports and legislation to determine the effects on the electricity supply business.
- NIE Networks has engaged with external industry consultants to develop overarching scenario worlds in an effort to model likely outcomes and timelines that certain decisions would have on the transition to Net Zero. The scenario Worlds provide;
  - a range of between 400,000 and 1.3 million EVs in operation in Northern Ireland by 2050;
  - variations of heat demand via electrification or hydrogen gas; and
  - varying levels of renewable energy sources connecting to the electricity network of between 60% - 80% RES-E. Further details on these scenarios are provided in Chapter 4.
- NIE Networks and SONI continue to collaborate with public sector, private sector and academia to lend its expertise to inform the energy strategy process. Both companies regularly engage with DfE under which a Joint Working group *(JWG)* was formed to jointly assess potential decarbonisation pathways for the energy sector and assess impacts on the electricity grid. This work culminated in an insight paper 'Energy Scenarios to Inform Developing Energy Strategy in Northern Ireland submitted to the DfE in December 2020. The JWG will remain in place throughout this process to continue to investigate pathway options and associated effects. Both organisations are engaged in supporting innovative projects and low carbon solutions for both heat and transport and in developing new TSO system services and new DSO services which are required to deliver Net Zero targets. The organisations continue to work together to explore how best to achieve this in Northern Ireland.

2.3.2 Customer

At NIE Networks we realise that customers are a major stakeholder in this transition. As a result,

NIE Networks has designed its strategy to be delivered in a way that works for people to reflect their priorities and choices. We recognise that while the transition will bring many benefits it also brings risks of uneven costs which NIE Networks will continually seek to mitigate. In Chapter 10 we outline a number of areas of our strategy where we are seeking customer and stakeholder feedback.

The transition to Net Zero emissions will be capital-intensive, with increased upfront spending that in turn yields ongoing savings in fuel costs. The costs of the investments in infrastructure will be financed either by a) charges directly levied on connecting customers or b) by NIE Networks, capitalised and included on the NIE Networks Regulated Asset Base *(RAB)* with the payback spread out over a 40-year period and cost recovery via the electricity bill *(on average circa 25% of the final bill related to network costs)*. In addition, increasing levels of electricity demand in Northern Ireland may help minimise any impact on the unit price of electricity as a result of the necessary increase in network investment that will be required. Further analysis is presented in Chapter 7.

However, policy decisions around how to mitigate against uneven costs should be given consideration. Continuing to add climate policy costs primarily to electricity prices, but not gas prices, adversely affects particular groups *(those with electric cars and heating)* and undermines the case for electrification, which plays a major role in meeting the Net Zero targets[60]. Electricity prices currently carry most climate policy costs. That increases electricity prices relative to natural gas and discourages a switch to lower-carbon electric heating. These costs must be a priority area for reform[61].

NIE Networks believe a customer centric approach is needed to deliver energy strategy at the most efficient cost for customers. The cost of electricity is important to customers, and as such the outworking of policy must consider the impact on costs and be balanced across current and future generations. It is important that it is a just transition with measures put in place to support and protect the most vulnerable in our society.

This strategy document builds upon work already completed and demonstrates that NIE Networks is actively engaged across a broad variety of stakeholders and external parties. This ensures that the NIE Networks strategy aligns with best industry practice and emphasises that it is more critical than ever that the electricity system is central to development of future energy strategy, so that energy security, resilience, and cost effectiveness is maintained through the entire value chain.

2.4 LOOKING FORWARD

2.4.1 Green Recovery

In the near-term, against the backdrop of the economic damage from the COVID-19 pandemic, the required investment for Net Zero could support the UK's and Northern Ireland's economic recovery. Longer term, it provides benefits in reduced operating costs, lower emissions and benefits to health and the environment, and possible intangible benefits for the UK internationally.

The pandemic and the measures introduced to respond to it are having huge effects on the economy that have not yet had their full impact. The latest Northern Ireland seasonally adjusted unemployment rate *(the proportion of economically active people aged 16+ who were unemployed)* for the period October - December 2020 was estimated from the Labour Force Survey at 3.6% and increased by 1.2pps over the year. These annual changes were described as statistically significant[62].

The UK's pathway to Net Zero requires a major investment programme that can help the UK's economic recovery. Strengthening energy system networks for a rapid increase in electrification and underpinned by an expansion of renewable electricity will stimulate highly skilled jobs and the value chains supplying them.

From a UK perspective the Prime Minister's ten-point plan aims to 'build back better' to invest in making the UK a global leader in green technologies. The ten-point plan will mobilise £12 billion of government investment, and potentially three times as much from the private sector, to create and support up to 250,000 green jobs.

There are approximately 821,000 domestic and 74,000 non-domestic buildings in Northern Ireland, with 67% of domestic properties being below EPC rating band C. In order to align with 2050 Net Zero commitments, it is estimated that policies would need to drive an annual peak of retrofits for over 50,000 buildings within the next decade. By comparison, current energy efficiency programmes in Northern Ireland deliver measures for approximately 16,500 buildings per year, indicating that a doubling or trebling is needed[63]. Importantly, this programme would be geographically dispersed, reaching all areas of Northern Ireland, with the potential to create local jobs.

In the long run, investments in low-carbon and adaptation technologies create a 'virtuous reinforcing cycle' as initial investments lower costs and help to accelerate deployment and innovation. This has been seen most dramatically in the wind, solar and battery technology industries. NIE Networks' assessment of how Northern Ireland can emerge from the pandemic and reinvigorate the economy is outlined in Chapter 9.

2.4.2 Medium Term

While many choices can be made now over the broad shape of the transition, there remain some decision points for government in the coming decade particularly surrounding electrification and hydrogen in buildings. Hydrogen has the potential to replace fossil fuels in areas where electrification may reach limits of feasibility and cost-effectiveness, including a partial role for heat in buildings. Gas distribution networks will not be able to continue to provide natural gas on a widespread basis by 2050 - they will either need to be decommissioned or, if feasible, repurposed to hydrogen. Decisions will be required from the mid-2020s on the balance between electrification and hydrogen in decarbonising heating in Northern Ireland, and the implications for gas networks. Until those decisions are made, options should be kept open by supporting pilot programmes and importantly accelerating deployment of 'least-regret' options *(such as heat pumps in homes off the gas grid).*

The relatively low costs of variable renewables, especially offshore wind, makes it attractive to lean towards 'over-building' renewable capacity relative to electricity demands, which generates a surplus of generation at some times during the year. Some of this generation that would otherwise be curtailed could potentially be utilised for hydrogen production or could be harnessed in energy storage applications such as hot domestic water, thereby providing extra value from the renewable capacity.

2.4.3 Sense of Urgency

The UK cannot achieve its climate targets without strong policy action across Scotland, Wales and Northern Ireland. The devolved administrations have an integral role to play in delivering the UK's path to Net Zero. The transition to a near-zero emission electricity system will have several phases:

- 2020s – Deploying low-cost renewables at scale, developing markets, developing the mandate of the Utility Regulator in line with Net Zero targets, ensure necessary funding is made available via the respective price controls to allow both NIE Networks and SONI to support the development and delivery of government policy in a timely and efficient manner, expansion of existing infrastructure *(e.g. electricity grids and electric vehicle charging networks, major renewable connection projects).*
- 2030s – Continued expansion of infrastructure as required, transitioning to a completely low-carbon system by displacing unabated gas with low-carbon alternatives by 2035, alongside ramping up deployment of zero-carbon generation to keep pace with electrification of end-use sectors and increasing potential for demand-side flexibility via electric vehicles, heat pumps, and hydrogen production.
- 2040s – Running a near-zero emission electricity system, with variability in renewable generation managed through flexible demand, medium-and long-term storage, and use of dispatchable low-carbon generation[64].

Progress Can Be Made Now

The pathways described in the subsequent chapters demonstrate possible strategies to underpin policy over the coming years. These pathways are based on known technologies and behaviours, with potential to be adapted as we learn more about the most effective ways to cut emissions. Even though there are many different scenarios that could lead to a Net Zero target, the implied flexibility on how to deliver it does not mean the near-term path is unclear. Many steps can be taken with confidence in the next decade and should begin immediately[65].

There are a series of actions that need to be taken now, while accepting that we can't know how every aspect of the transition will play out. Reaching a point at which all new investments in assets are compatible with Net Zero cannot happen overnight. Lead-times from policy to investment and impact, together with the need to scale up markets, supply chains and supporting infrastructure, as well as public acceptance of new solutions, means most policies must be at least outlined in the coming year and firmed up before 2024 or earlier.

The CCC concludes that it would not be appropriate to act more slowly, reflecting that our actions ultimately affect the UK's global

contribution to the Paris Agreement and therefore decrease the likelihood of global temperature increases. Delivery of a Net Zero ambition and future targets requires a coordinated effort from all principal actors with a framework of goals and performance monitoring. This is particularly relevant in Northern Ireland where targets can be impacted by multiple agencies, government departments and industry.

3. THE CUSTOMER

CHAPTER 3 – THE CUSTOMER

- **What It Means for Customers** – Customers are already involved in taking steps to reduce emissions through the adoption of low carbon technologies such as electric vehicles and photovoltaic solar cells. These will deliver benefits and new opportunities for customers and potentially place downward pressure on electricity bills.
- **What Customers of the Future Might Look Like** – The development of trading arrangements will lead to classification of customers as being 'Active' or 'Passive in the future:
  - Active – System service provider: highly enabled customers participating in support services to the network operators e.g. large customers and aggregators.
  - Active – Participants: customers deriving income from generators / storage or reducing costs through low carbon technologies.
  - Passive – Participants: smaller energy conscious customers adopting off-the-shelf low carbon technologies to reduce their overall costs or for social responsibility reasons.
  - Passive – Consumers: domestic or smaller non-domestic demand customers with little or no interest in the flexible energy market or low carbon technologies.
- **Future Technologies, and Customer Choices and Behaviours** – There could be opportunities for customers to earn value for themselves through self-generation, demand management, greater energy efficiency, energy storage, and selling electricity back to the grid or other customers.
- **Engaging and Empowering Customers** – it is crucial that changes to the operation of energy markets work for all customers whether they are acting in an active or passive manner. NIE Networks is committed to assisting all customers, whatever type of customer they happen to be.
- **Information Provision** – Energy is already a challenging area for domestic customers to understand and provision of relevant information on options is important. NIE Networks sees merit in a centralised body for provision of information and is keen to contribute to this body. NIE Networks considers smart metering technology with accurate and timely consumption and financial data is essential for customers to have better control over how and when they use electricity. It is time now to progress a smart metering programme as a key enabler and review the business case as a matter of urgency.
- **Looking After All Our Customers** – The journey to Net Zero has a risk of being unequal and leaving people behind due to the complexity and cost of participation. NIE Networks will try to ensure that this does not see anyone being left behind.
- Consideration is required for vulnerable customers and tariff reform is essential to ensure that the cost of network usage is spread fairly between customers.
- NIE Networks considers there may be three direct ways that it can help minimise any detriment experienced by any such customers:
  - We can help address the problem of lack of skills, knowledge and/or confidence by doing our part to ensure the quality and accessibility of information to the public.
  - We will work to introduce reforms to the Distribution Use of System tariffing arrangements to ensure that costs of the network are fair to all customers.
  - We will continue to focus on efficient delivery of our services to ensure any expenditure on the network is necessary and is incurred as efficiently as possible.
- **Connection Charging** – In Northern Ireland the connecting customer pays for the full cost of the connection works up to and including the next voltage level. This is different in GB and RoI where a portion of the total cost is socialised. The current charging mechanism may deter many domestic customers from adopting low carbon technologies and indeed can deter inward investment through Northern Ireland being uncompetitive with neighbouring jurisdictions.

3.1 WHAT IT MEANS FOR CUSTOMERS

The climate change challenge will drive decarbonisation of society and the impacts of this will be profound and far reaching, not least for the energy sector. The changes that are underway are already impacting on how customers are engaging with the electricity network:

- more than 20,000 customers are now generating for their own consumption or exporting to the network;
- there has been a significant uptake of solar PV on rooftops which also permits customers to utilise their energy sources more efficiently;
- there has also been an uptake in electric vehicles with many owners installing smart chargers at their premises.

These changes point to customers having the ability to move away from being a pure demand customer to one that can make choices to manage their energy needs more proactively and make efficiencies. Further changes can be facilitated with current technology but require some further policy decisions. For example;

- the introduction of smart meters will provide better and real time information on energy usage and facilitate the introduction of more flexible tariffs;
- blockchain technology can facilitate peer to peer trading; and
- electric vehicle owners will be able to use their car battery in 'vehicle to home' mode to power appliances or 'vehicle to grid' mode to export excess energy.

The changes that are coming will place increasing demands on the electricity network which will in turn require a different approach for NIE Networks in how it manages and operates the network, and also how customers can participate *(or otherwise)* in new energy markets. Examples of such changes, many of which are already having an impact, include;

- the continued growth in renewable generation;
- an accelerating uptake in electric vehicles and electric heat pump installations; and
- more and more customers installing technologies that allow them to produce and store their own electricity, and/or have better control over how they use electricity more efficiently.

In the past the flow of electrical energy was predominantly in one direction, being from a large generator such as a power station towards the end customer; but we are now currently experiencing increasing energy flows in all directions as smaller-scale and distributed generation proliferates. Distribution Network Operators *(DNOs)* have already started to play a more active role in the operation of the electricity system, performing new roles and functions as part of the transition to a DSO which is outlined in Chapter 6. Technology has enabled this change away from a traditionally passive role of transporting electricity through the distribution network in one direction, to that of playing a much more active role in network control and management.

If managed effectively, the shift away from the old model of how the network operated to a new operating model will deliver real benefits, create new opportunities for customers and place downward pressure on electricity bills. It will enable the more active management of the network through increased customer participation and for the network to act as a platform for the greater deployment of smart energy technologies as alternatives to conventional higher cost investments.

The transition to Net Zero emissions will be capital-intensive, with increased upfront spending that in turn yields ongoing savings in fuel costs. The costs of the investments in infrastructure will be financed either by a) charges directly levied on connecting customers or b) by NIE Networks, capitalised and included in the NIE Networks Regulated Asset Base *(RAB)* with the payback spread out over a 40-year period and cost recovery via the electricity bill *(on average circa 25% of the final bill relates to network costs).*

In this Chapter we focus on the customer, and in particular the likely impact on customers' opportunities and behaviours when the potential changes to energy markets which are needed to meet society's Net Zero aspirations, come to fruition.

3.2 WHAT CUSTOMERS OF THE FUTURE MIGHT LOOK LIKE

Customers in the new DSO world will generally be either 'active' or 'passive' in terms of their participation in energy markets. As these descriptors suggest, an active customer would be actively engaged and participating in these markets whereas a passive customer would not participate actively *(although note they could participate passively)*. The Electricity Directive[66] of the European Clean Energy Package specifies a number of rights and responsibilities for active customers and the DfE intends to legislate for these in parallel with the development of Northern Ireland's new energy strategy[67].

Working in conjunction with the ENA Open Networks Project[68], we have categorised customers into four potential groupings as follows:

- Active customers: *(1)* System service providers; or *(2)* Active participants.
- Passive customers: *(3)* Passive participants; or *(4)* Passive consumers.

These customer types, as illustrated in Figure 8, are described further below.

Figure 8 – Future Customer Categories

3.2.1 System Service Providers

These are sophisticated and highly enabled customers who would opt to sell system support services to the TSO or NIE Networks as DSO who, acting in their roles as operators of the electricity network, require such services to make sure the network remains stable and safe. These customers have generally invested in specialist equipment that enables them to participate in the energy market and provide support services, or they are demand customers who are more aware of the energy market and can flex their electricity usage as part of their business, for example through demand side management. This customer category includes larger individual customers and also aggregators providing services through the management of a portfolio of smaller customers. The TSO or NIE Networks would agree term contracts on a bilateral basis for the services they need.

3.2.2 Active Participants

These customers are also sophisticated and highly enabled, and have invested in distributed energy resources *(DER)*, demand side management or LCTs. This customer category will include customers actively participating in the energy market to derive income from generation and/or storage, demand customers whose goal is to reduce operating costs and larger customers who have invested in LCTs for social responsibility reasons. They are very likely to be responding to time of use signals, including managing demand or export at times of peak demand. While these customers will have bilateral contracts with suppliers for energy services they will not have contracts for services with TSOs or DSOs.

Typical customers in this category are storage providers, distributed generators and flexibility service operators, larger demand customers and community energy schemes; however, this category also includes aggregators managing exports and demand side management on behalf of multiple smaller customers.

3.2.3 Passive Participants

This customer category includes smaller energy conscious customers *(domestic or non-domestic)* who have invested in 'off the shelf' LCTs to derive income from renewable energy schemes, for the purpose of reducing their overall costs or for social responsibility reasons. Electrical generation and/or consumption are unlikely to be actively managed and are instead installed and utilised on a passive 'fit and forget' basis. 'Off the shelf' LCTs in this case include solar panels, heat pumps, electric vehicles and other smart devices *(reference Figure 9)*. These customers are likely to be both exporting and importing and would seek to benefit from time of use tariffs offered by suppliers.

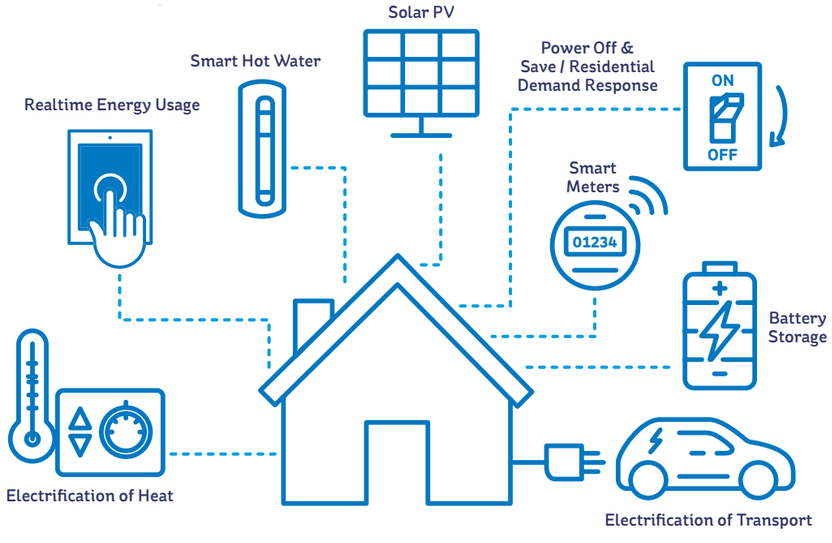


Figure 9 – Passive Participants[69]

CASE STUDY – RULET BY ULSTER UNIVERSITY

The electrification of heat and transport, along with the need for more renewable generation to meet the UK Net Zero 2050 target requires a significant increase in power system flexibility to maximise system efficiency and to complement output from non-dispatchable renewables like wind and solar energy. Flexibility can be derived from a range of sources, including battery systems, fossil generators and interconnectors, dynamic domestic demand enabled by new business models and consumer-owned LCTs such as smart immersions heaters, domestic PV, heat pumps, thermal / battery storage and EVs.

NIE Networks is supporting an Ulster University and Northern Ireland Housing Executive (NIHE) led project termed 'Rural Led Energy Transition' (RULET) which seeks to enable low-income households to act as participants in various energy markets and prevent them being left behind in the transition to smart, integrated energy systems.

The project seeks to demonstrate and quantify how domestic electrical heating systems, combined with thermal storage and smart control technologies have the potential to create substantial system value by providing this flexibility. It involves a trial in up to 100 NIHE-owned homes of standalone and hybrid heat pumps with thermal storage installations to provide flexible load to make use of low- or zero-cost wind energy. It will assess how electrical heating, energy storage and smart control technologies could create new business and ownership models for flexible heat demand. The project will also model the impacts of extensive uptake of flexible electrical heating systems in NIHE's c.80,000 dwellings

(Further information on this project is available in Appendix 11.1.)

3.2.4 Passive Consumers

This customer category would normally comprise domestic or smaller non-domestic demand customers with little or no interest in the flexible energy market or LCTs. These customers may have smart appliances and in due course could agree smart energy contracts with suppliers and aggregators *(at which point the key relationship is between the DSO and the aggregator / supplier, and thereafter the customer would progress out of this category).*

This category includes customers in social or private housing with or without access to a community energy supply contract via their landlord. These customers are likely to be on a standard supplier tariff.

3.3 FUTURE TECHNOLOGIES, CUSTOMER CHOICES AND BEHAVIOURS

Through our DSO transition work[70] NIE Networks is committed to enabling the uptake of various new technologies by customers, and facilitating choice in the mode of operation of these technologies. Going forward it is likely that the energy market place will operate in a more dynamic and decentralised manner, creating much more choice for active and engaged customers as to how they consume *(and generate)* electricity. There could be excellent opportunities for such customers who have the resources, know-how and/or motivation to earn value for themselves through self-generation, demand management, greater energy efficiency, energy storage, and selling electricity back to the grid.

Such customers could earn value for themselves by way of:

- self-generation e.g. using solar panels or wind turbines;
- using storage technologies, such as battery storage or Vehicle-to-Grid capabilities to smooth out periods of self-generation / self-demand mismatch and to support the network;
- reducing electricity usage through the installation of demand reduction equipment. This could be combined with time of use tariffs which, either by way of manually adjusting their own consumption patterns or using a third-party service provider to do it for them, will lower their costs of consumption;
- participating in local or peer-to-peer energy supply markets by way of: *(1)* purchasing electricity from local generation at potentially lower cost; and/or *(2)* selling back to the network or other customers if the customer is self-generating and in surplus; and/or
- paying less in network charges *(at least, until or unless the current tariffing arrangements are changed to be less volume driven).*

The above list is not intended to be exhaustive as there may be other ways for active customers to earn value for themselves.

3.3.1 Engaging and Empowering Customers

We recognise that how customers engage with energy markets will evolve with time, and customers may move between the categories described above, depending on their needs and circumstances. It is also clear that not every customer will want to or be able to take advantage of value-gaining opportunities created by new energy markets. Therefore, it is crucial that changes to the workings of energy markets must be made to work for all customers whether they are acting in an active or passive manner. NIE Networks is committed to assisting all our customers, whether active or passive.

Helping Active Customers

NIE Networks can facilitate active and engaged customers by creating the right conditions for new electricity markets and services to flourish. One example of this is the ongoing Flex project which is developing a platform for customers to provide flexibility services to the DSO in exchange for financial reward. This project is detailed further in Chapter 6 and Appendix 11.3.

Additionally, NIE Networks will facilitate distribution customers participating in electricity markets through services such as reducing demand, increasing generation or adjusting reactive power in response to system events or in receipt of a dispatch signal while ensuring that the quality, safety and security of supply is maintained for all customers.

Providing Clear and Accessible Information for Our Customers

Customers will in most instances require access to fair, impartial and comprehensive advice and information to allow informed decision making. Energy is already a challenging area for domestic customers to understand even before adding the complexity that the energy transition will bring.

In Northern Ireland, advice and information for energy customers is provided by a range of different organisations such as the Consumer

Council for Northern Ireland, the Utility Regulator, the Northern Ireland Energy Advice Line, energy suppliers, energy networks, and government departments, who will have specific areas of expertise in aspects of energy markets and the energy transition.

The Energy Data Taskforce (EDTF) was commissioned by the Government and Ofgem and in their report 'A Strategy for a Modern Digitalised Energy System' set out five key recommendations for modernising the GB energy system and drive it towards a Net Zero carbon future through an integrated data and digital strategy.

The recommendations highlight that the move towards a 'Modern, Digitalised Energy System' is being hindered by often poor-quality data. The EDTF delivered a strategy centred around two key principles:

a) filling in the data gaps through requiring new and better-quality data; and

b) maximising its value by embedding the presumption that data is open.

These two principles will start to unlock the opportunities of a modern, decarbonised and decentralised energy system for the benefit of consumers. Whilst the EDTF recommendations are not yet applicable in Northern Ireland, NIE Networks is engaging with the ENA to understand and follow the progress being made in GB. We consider that the findings on data visibility, open markets and agile regulation should be applied in Northern Ireland to improve access to data and maximise its value.

To help foster a future where energy customers can access the information they need more easily, especially in the context of the evolving role of the DSO and the enhanced ability of customers to participate actively in new electricity markets, we consider there is merit in NIE Networks contributing significantly to a centralised independent body for provision of information and advice to customers. As part of this service we would use our expertise and understanding of the DSO function and the markets that it enables, to provide impartial advice and information via this newly formed centralised information provider.

Smart Metering

Smart metering technology with accurate and timely consumption and financial data is essential for customers to have better control over how and when they use electricity. This would maximise the financial benefit for the customer, from adopting low-carbon technology such as solar panels and storage technology, or simply benefiting from making more informed choices such as shifting their consumption to times of lower electricity prices.

The Department for Business, Energy and Industrial Strategy *(BEIS)* is supportive of a continued smart metering roll-out across GB, however, at present there is no mandated smart metering programme for Northern Ireland. NIE Networks considers it is time now to progress a smart metering programme as a key enabler and would support a review of the case for smart metering to ensure both customer and network benefits are assessed.

3.3.2 Looking After All Our Customers

The changes that will emerge with the energy transition and journey to Net Zero have a risk of being unequal in the sharing of system benefits and costs; and to potentially leave people behind in terms of the complexity and cost of participation in the full range of benefits of the future energy system. NIE Networks will try to ensure that this does not see anyone being left behind.

Risks would arise through customers:

- having insufficient access to finance for the upfront costs needed for new technologies;
- lacking the skills, knowledge and/or confidence needed to use the technologies, apps or websites etc to avail of new services;
- not being sufficiently motivated to engage and participate in the energy market; or
- feeling a lack of trust in energy suppliers and other companies in the energy market, and so do not wish to avail of any services that hand over control of their consumption *(or generation).*

For such customers the potential impacts, absent any remedial actions to prevent these, could be:

- missing out on the rewards of active engagement by way of receiving better services, or paying less for services, or receiving an income for providing services back to the network; and/or
- finding themselves saddled with extra costs e.g. if a large number of engaged customers go 'off-grid', it could result in those left on the grid having to pay more for it.

NIE Networks considers there may be three direct ways that it can help minimise the detriment experienced by any such customers:

1. we can help address the problem of lack of skills, knowledge and/or confidence by doing our part to ensure the quality and accessibility of information to the public.
2. we will work with the Utility Regulator to introduce reforms to the Distribution Use of System *(DUoS)* tariffing arrangements, to ensure that costs of the network are paid for in a manner which is fair to all customers; and
3. we will continue to focus on efficient delivery of our services in general to ensure any expenditure on the network is necessary and is incurred as efficiently as possible.

Helping Vulnerable Customers with Advice and Information

Just as we envisage using our knowledge and expertise to assist active and engaged customers get the most out of the future energy system we would do likewise for vulnerable customers who are passive and disengaged for reasons of lack of knowledge, understanding, finance or motivation.

This is clearly an area that requires greater consideration and collaboration to develop the idea further, including how best to create a coherent and coordinated programme that cuts across the various organisations that have responsibilities for the protection of vulnerable customers. The ultimate aim being to develop a programme *(or series of programmes)* of support which increases participation among specific vulnerable customer groups.

In this regard NIE Networks is fully committed to playing its part in helping vulnerable customers with advice and information. NIE Networks will be launching its Vulnerable Customer Strategy in 2021 as it seeks to provide extra help and support for customers whose personal characteristics or circumstances reduce their ability to engage effectively and achieve fair outcomes.

Tariff Reform

DUoS tariffs are designed to recover the distribution network costs from end users based on how they contribute to network costs. Our DUoS tariffs currently are primarily volume based with approximately 74% of distribution revenue recovered from unit *(kWh based)* charges. However, there are a number of potential issues with this volumetric approach which could prove problematic as we transition to Net Zero carbon.

Firstly, as more and more customers start self-generating the volume of electricity they consume via the distribution network may reduce in aggregate; and so, under the current volume-driven tariff arrangements, the contribution they make towards network costs may also reduce. The end result could be that a higher proportion of network costs are left to be recovered from customers who are more reliant on the electricity distribution network for meeting their electrical demands and this could be considered to be unfair.

A second issue, and one which may serve to counterbalance the above issue of reduced consumption via the distribution network, is that customers may end up consuming a much greater volume of electricity units to heat their homes and/or charge their electric vehicles. If their electrical demands are met only via the network these customers would end up paying proportionately more towards network costs under the current volume-driven tariff arrangements than they did before and this again could be considered to be unfair.

To address these issues, it may be more appropriate if in future, the DUoS tariffing arrangements are amended from primarily a volumetric approach to a more capacity charging approach, much like paying for broadband capacity rather than data usage. Accordingly, NIE Networks would support a comprehensive review of the DUoS charging methodology to be led by government and/or the Utility Regulator. This review could include detailed analysis of the allocation of costs to customer groups and types of charges.

Such a review would focus on developing options as follows:

- Rebalancing of DUoS charges. Reducing the proportion of costs recovered from volume-based unit charges and increasing the proportion recovered from fixed charges *(i.e. capacity or standing charges)* with a focus on a fair and appropriate cost recovery from all customers.
- Developing new tariff groups or charging arrangements. Developing new cost reflective tariffs or charging arrangements to recognise common modes of behaviour, with price incentives for LCT and flexible users and charging arrangements to encourage generators to locate close to customer demand.
- Develop Time of Use pricing. This area of reform has two parts:

– encouraging a higher uptake in Economy 7 type tariffs by small business and domestic customers in general; and

– developing appropriate time of use charging arrangements for new technologies.

The review could also consider the balance of costs between customer groups when developing options, as it will be important to encourage the uptake of new technologies and to ensure vulnerable customers are protected.

Keeping Costs Low Through Efficient Service Delivery

NIE Networks strives at all times to deliver high quality services that our customers require and value at least possible cost. When we develop business plans for the periodic price controls we ensure that investment planned for the network is necessary to enable us to carry out our transmission and distribution functions to an appropriate standard and to provide a network which is fit for purpose for our customers. This in turn ensures network tariffs remain as low as possible. There has been approximately a 30% real price reduction in our network costs since privatisation.

Our focus on efficient service delivery will continue throughout the energy transition and journey to Net Zero.

Customer Connections

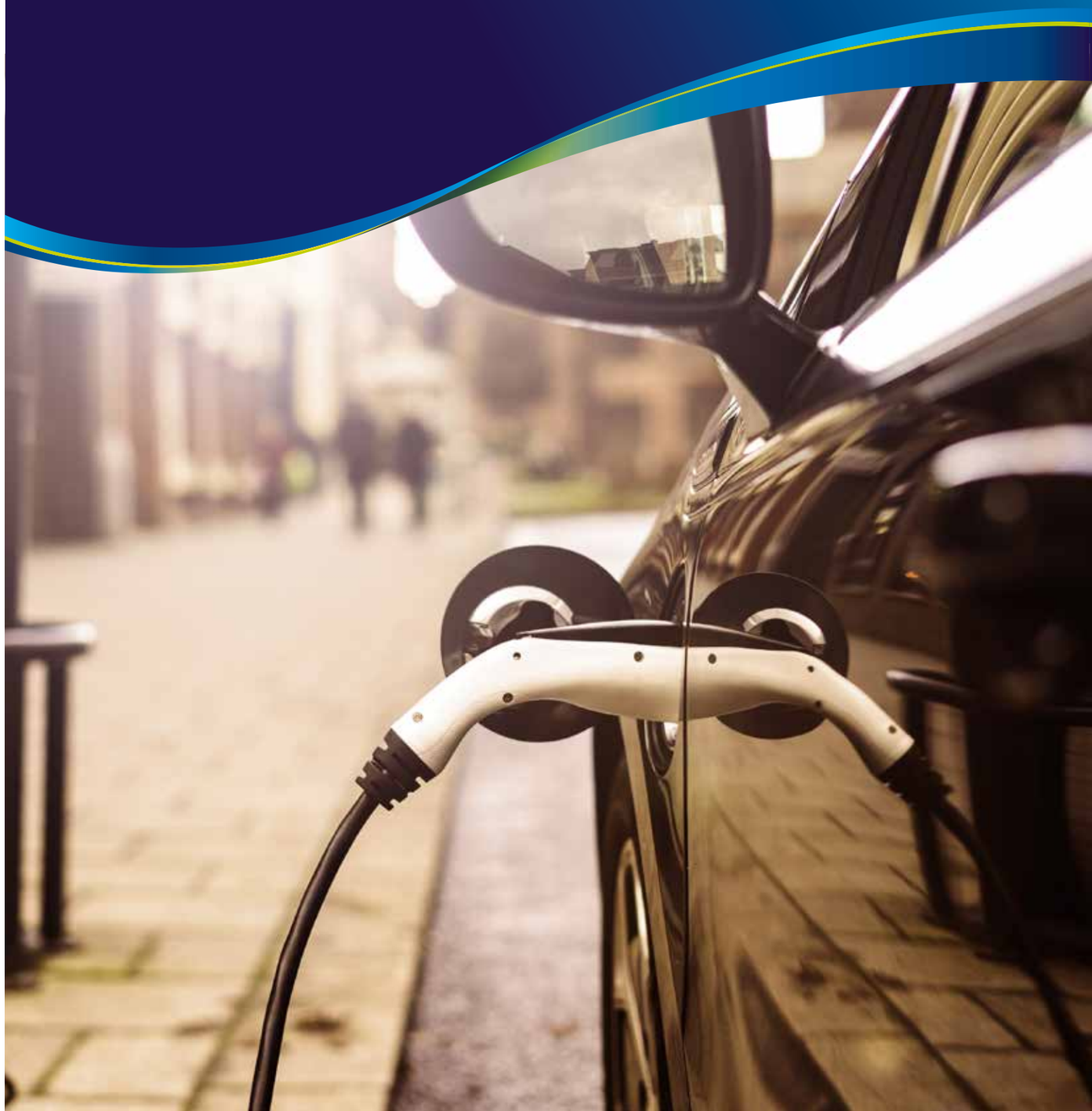
A further area of impact for customers which is under consideration is the cost of connecting new customer premises or technologies to the distribution network. The current charging mechanism may deter many domestic customers from adopting LCTs. This is a particular problem in Northern Ireland since, unlike GB, the connection charging policy requires the full distribution connection charge, including network reinforcement, to be levied directly on the connecting customer.

By contrast in GB, customers pay upfront for new distribution network connecting assets but only a share of any necessary reinforcement of the upstream network. The remainder of reinforcement costs is socialised and recovered within GB network charges. Furthermore, Ofgem is currently considering reducing or removing entirely any network reinforcement costs included in charges applied to customers connecting LCTs. The thinking being that such a change in policy would reduce barriers to small users adopting LCTs. In RoI, a proportion of the cost of connection is socialised.

NIE Networks considers the connections model followed in GB or the RoI may be better suited for facilitating the journey to Net Zero and would advocate for an urgent review of and consultation on the connection policy and connection charging regulations in Northern Ireland to encourage the connection of LCTs.

Northern Ireland Electricity Networks

4. THE JOURNEY TO DECARBONISATION



CHAPTER 4 – THE JOURNEY TO DECARBONISATION

- **Pathways to Decarbonisation** – A range of pathways are assessed considering uptakes of low carbon technologies and ability to achieve emissions reduction targets. Five Element Energy scenario worlds depending on the rate and uptake of storage, EVs, solar PV and heat are considered. The scenarios assessed for the various technologies were then used as inputs to further modelling undertaken by a NIE Networks / SONI Joint Working Group which concluded that in two out of three TESNI pathways the Northern Ireland Net Zero GHG emission reduction ambition can be met. This pathway modelling was presented in a report to the DfE and some key findings are outlined here.
- **Sources of Carbon Emissions in Northern Ireland** – these differ from the remainder of the UK due to:
  - a significant share of oil in the heating sector;
  - a high proportion of grassland;
  - an underdeveloped gas grid relative to the rest of the UK; and
  - the high proportion of livestock in the agriculture sector.
- **Scenario Worlds** – Of the five Element Energy scenario Worlds, four of these are consistent with the UK achieving a net zero energy system by 2050 *(Worlds B, C, D and E)*. World A represents delayed policy action resulting in failure to meet the UK 2050 net zero target. Worlds A, B and D are the input models that inform the SONI Tomorrow's Energy Scenarios NI report and also the NIE Networks / SONI joint working group report.
- **Decarbonisation of Generation** – Scenarios for the decarbonisation of the electricity grid considered targets of between 60% and 80% renewable energy resources by 2030 rising to between 80% and 90% by 2050.
- **Gas v Electricity Demand** – In two of the scenarios Worlds *(C and E)* the gas grid undergoes a transformation and maintains a substantial role in the energy system. In scenario Worlds B and D, the gas grid's role is diminished and deep electrification occurs instead.
- **Demand** – The decarbonisation of demand relies on both customer behavioural change and change on the part of large industrial operations to limit reliance on fossil fuels and actively engage with more energy efficient processes.
- **Energy Efficiency First** – Energy efficiency is a key driver to reduce greenhouse gas emissions and is a vital primary strategy to reach net zero. One of the three key targets of the EU's 2030 Climate and Energy Framework is a 27% improvement in energy efficiency. Efficiency improvement initiatives include better insulated buildings, improving vehicle efficiency and improving industrial process efficiencies.
- A DfE research report has highlighted the range of economic and wider societal benefits that can be achieved by significantly improving how we use energy. This will need a blend of policy levers, significant investment and appropriate policy to implement. The Economy Minister states that "The first step in decarbonising our energy mix is to actually use less".
- The report suggests that Northern Ireland requires a significant retrofit programme over the next decade.
- **Pathways** – A detailed discussion on the various TESNI pathways and Element Energy scenarios is provided for uptake levels of EVs, heating, transport, solar PV and storage with quantification against various policy drivers for each sector.
- **Modelling Findings** –
  - **Decarbonisation** – The analysis confirms that in four of the five Element Energy scenarios and two of the three TESNI pathways modelled, Northern Ireland can achieve the level of decarbonisation recommended by the CCC to achieve Net Zero in the UK by 2050. Detailed analysis with quantification is provided.
  - **Electrical Demand** – Decarbonisation of heat and transport primarily could result in an increase in electricity demand by up to 70% by 2050.
  - **Primary Energy** – Despite this increased electricity demand from the increased penetration of renewables and LCTs, with higher efficiency gains and the shift away from fossil fuels, it is assessed that total primary energy usage in Northern Ireland would fall by circa 44% by 2050 in comparison to 2020 levels.

4.1 PATHWAYS TO DECARBONISATION

In delivering its fair share of GHG emission reductions as part of the UK commitment to Net Zero by 2050, the period from 2021-2030 is a critical one for all sectors in Northern Ireland including the energy sector. There are a range of pathways based on different policy levers, market conditions and customer choice that will influence whether this can be achieved and if it can, the speed and rate of reductions to meet future targets. The NIE Networks and SONI joint working group *(JWG)* recently completed a study into different pathways and submitted this to the DfE[71] for consideration in the emerging energy strategy for Northern Ireland. This Chapter will present an insight to the modelling that was undertaken by NIE Networks as part of that process to understand the range of uptake scenarios for LCTs and the range of impacts on the electricity networks and on emission reduction possibilities. It will also draw on some of the conclusions of this analysis and of the joint NIE Networks / SONI work.

Element Energy was commissioned by NIE Networks in 2019 to develop a set of scenario Worlds for the uptake of LCTs and low carbon generation over the period 2020 to 2050. The data in this chapter utilises these uptake scenarios and converts the uptake of new and existing technologies to carbon emissions arising from the consumption of fuel *(natural gas, petroleum, coal, hydrogen, bioenergy and electricity)* in buildings, on road transport and from industrial processes.

The overall impact on emission reductions is presented with an assessment of the direct cost implications for network investment to enable the increased electrical demands outlined in Chapter 7.

4.1.1 Sources of Carbon Emissions in Northern Ireland

At present, fuel consumption from buildings, road transport and industry is estimated at 47 TWh, mostly from the consumption of petroleum in the transport and heating sectors, as well as natural gas and electricity. This fuel consumption emits an estimated 12.6 $MtCO_2/yr$[72] *(c64% of total from Figure 2).*

There is a strong prevalence of oil in the domestic and industrial & commercial *(I&C)* sectors, especially in the rural areas of Northern Ireland. In 2019, petroleum accounted for 42% of building fuel consumption, electricity 26% and natural gas 24%, with solid fuels making up the remainder.

Domestic and I&C fuel consumption accounted for 67% of CO_2 emissions considered in the modelling. The remaining 33%, or 4.2 $MtCO_2$, are emitted from the combustion of petrol and diesel in the road transport sector. Fuel consumption was calibrated to reports from the Utility Regulator for electricity and gas, and the BEIS residual fuels dataset for other consumption.

The CCC's recent 6th Carbon Budget suggests that Northern Ireland is likely to be the slowest UK devolved administration to decarbonise and that the earliest credible year for Net Zero GHG emissions is post-2050 although it is expected Northern Ireland could be Net Zero carbon by 2050. This is largely due to:

- a significant share of oil in the heating sector;
- a high proportion of grassland;
- an underdeveloped gas grid relative to the rest of the UK; and
- the high proportion of livestock in the agriculture sector[73].

However, some small amount of remaining emissions in Northern Ireland's energy system in 2050 is still compatible with the UK Net Zero target.

4.1.2 Introduction to Scenario Worlds

There is uncertainty both in the level of emissions that can and will be achieved in Northern Ireland over the period to 2050 and the specific pathway that will be followed to deliver this reduction. Given this uncertainty, five scenario Worlds were developed that take the individual scenarios *(low, medium, high etc.)* for each technology driver *(EVs, solar PV etc.)* and create a holistic view of the future. The key drivers considered were in power, heat and transport i.e. wind power, solar PV, electric vehicles, storage and heating options.

The level of decarbonisation ambition of a scenario World is defined by nationwide target setting. The term 'Net Zero scenario world' for Northern Ireland is defined as a future energy system which is compliant with the UK net zero target, but that may not be Net Zero in isolation, i.e. it represents Northern Ireland's contribution to a UK Net Zero energy system which is proposed as an 82% emissions reduction from 1990 levels by 2050. Of the five scenario worlds developed, four of these are consistent with the UK achieving a Net Zero energy system by 2050 *(Worlds B, C, D and E)*. This reflects the significant uncertainty in key areas such as the decarbonisation of heating. A fifth scenario *(World A)* sees delayed policy action resulting in slower decarbonisation and, therefore, failure to meet the UK 2050 Net Zero target.

A more detailed description of the scenarios is presented below.

World A – This is the least ambitious scenario with a rate of change insufficient to meet Net Zero carbon emission in 2050 with a 60% Renewable Energy Source *(RES)* target by 2030.

World B – This scenario achieves significant decarbonisation, consistent with the UK reaching a Net Zero carbon emission energy system by 2050 with a target of 70% RES by 2030, through a high degree of electrification of both heat and transport demands.

World C – This scenario achieves significant decarbonisation, consistent with the UK reaching a Net Zero carbon emission energy system by 2050 with a target of 70% RES by 2030, through deep electrification of transport and decarbonisation of the gas grid.

World D – This scenario achieves significant decarbonisation, consistent with the UK reaching a Net Zero carbon emission energy system by 2050 but is extremely ambitious with a 2030 target of 80% RES. It is similar to scenario world B in which there is deep electrification of demand; but in this scenario there is even more rapid electrification of passenger vehicles.

World E – This scenario is very ambitious and compatible with Net Zero emissions by 2050. The only difference between Scenario worlds E and D is the way in which heat demand is met, with the focus on a repurposed natural gas grid to distribute hydrogen *(as with Scenario World C)* rather than high levels of electrification.

The information from these pathways dove-tailed into the work undertaken by the TSO in their Tomorrow's Energy Scenarios *(TES)* with 3 of these worlds *(A, B and D as per Table 2)* being taken forward for further assessment of emissions reduction and network impacts.

Element Energy World	RES at 2030	Sensitivity Onshore Offshore	Solar	EV	Storage	Heat	TES Alignment
A	60%	All Onshore	Low	Med	Low	Med	Modest Progress
B	70%	Onshore plus a minimum of 350MW Offshore	Med	High	Med	High E	Addressing Climate Change
C	70%	All Onshore	Med	High	Med	Low E & H2	-
D	80%	Onshore plus a minimum of 350MW Offshore	High	Very High	High	High E	Accelerated Ambition
E	80%	Onshore plus a minimum of 350MW Offshore	High	Very High	High	Low E & H2	-

Table 2 - Element Energy World Scenarios and Their Alignment with SONI TES Scenarios

4.1.3 Decarbonisation of Generation

Decarbonisation of the energy system will rely on a gradual transition away from fossil fuels *(petroleum, coal, natural gas)* towards renewable electricity, renewable gas and bioenergy. Whilst bio-diesel and other bio fuels show promise and will form part of the solution, there is insufficient bioenergy resource to fully decarbonise petroleum consumption; therefore, it is necessary to switch consumption towards other energy sources that can be more easily decarbonised.

Electricity

The Northern Ireland electricity grid serves 821,000 domestic customers[74] and 74,000 I & C customers, who consumed 7.5 TWh[75] of electricity in 2019. Scenarios for the decarbonisation of the electricity grid have been developed around RES targets, as shown in Figure 10. The scenarios achieve between 60% and 80% RES by 2030, rising to between 80% and 90% by 2050. Grid intensity reduces from 0.28 kgCO_2/kWh in 2020 to 0.01 - 0.04 kgCO_2/kWh by 2050.

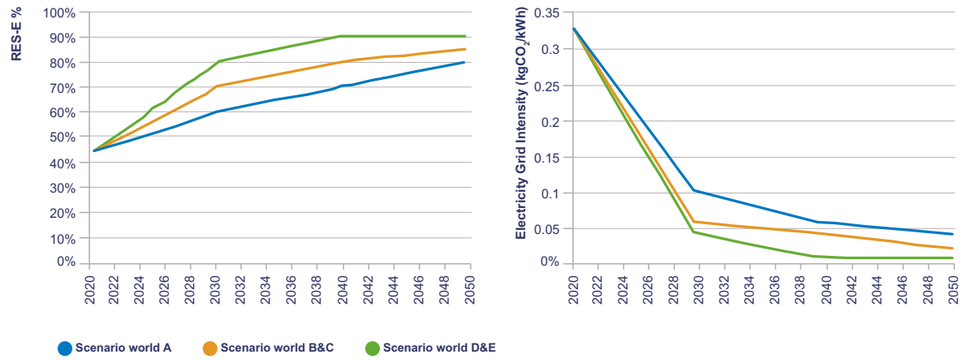


Figure 10 - Electricity Grid Scenarios in Terms of RES % (Left) and Carbon Intensity (Right)

Gas

The gas grid in Northern Ireland is undergoing a significant expansion via the Gas to the West project[76]. By the end of 2022, gas is expected to be available to 585,000 properties with an ambition of over 300,000 to be connected[77]. Gas is becoming an increasingly important energy source in Northern Ireland's energy system, but as natural gas is not consistent with a decarbonised future, there is a high degree of uncertainty in future strategy for the network without undergoing a significant transformation to hydrogen.

Although the idea of a hydrogen transformation is gaining momentum in the UK and more widely, there are still unresolved questions regarding its technical feasibility and commercially viability. For these reasons, the CCC has proposed that the 2020s should be a period of trial for hydrogen in the UK with its assessment that perhaps only 11% of homes would be heated by hydrogen with focus around industrial centres.

Several scenarios are considered to reflect this uncertainty, each describing different pathways for Northern Ireland's energy system, see Figure 11 and Figure 12 *(note that this does not include gas demand in the road transport sector, which would not necessarily utilise the gas distribution grid infrastructure).* In scenarios Worlds C and E *(Figure 13)* the existing gas grid undergoes a transformation and maintains a substantial role in the energy system. In scenario Worlds B and D (*Figure 12)* the gas grid's role is diminished and deep electrification occurs instead. In reality, the pathway for heat decarbonisation in Northern Ireland could be a mix of these components.

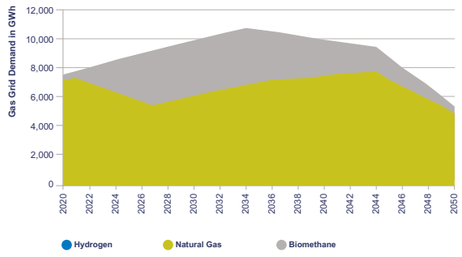


Figure 11 - Scenario A Gas Grid Demand

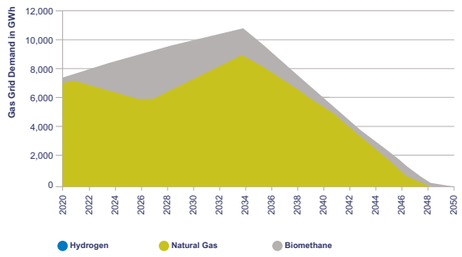


Figure 12 - Scenarios B and D Gas Grid Demand

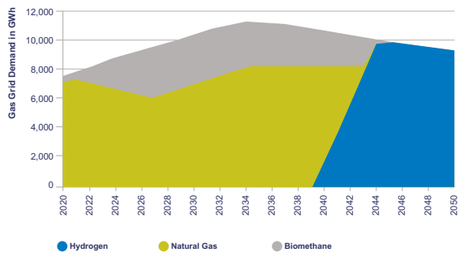


Figure 13 - Scenarios C and E Gas Grid Demand

Bioenergy

Northern Ireland represents approximately 3% of the UK's population but accounted for an estimated 5%[78] of the UK's total bioenergy and waste to energy consumption in 2018. This owes largely to its higher resource potential due to its higher share of agricultural area, relative to the rest of the UK. This suggests that future biomass use may be more concentrated in devolved administrations, such as Northern Ireland.

Element Energy have estimated Northern Ireland's bioenergy resource to 2050 for three different scenarios *(matching Worlds A, B & D and C & E)* which are based on a disaggregation of the overall UK bioenergy resource, as estimated by the CCC[79]. The results estimate that Northern Ireland's technical potential for bioenergy in 2050 is estimated at 3,500 to 14,400 GWh of primary energy.

4.1.4 Decarbonisation of Demand

The decarbonisation of demand relies on both customer behavioural change and change on the part of large industrial operations to limit reliance on fossil fuels and actively engage with more energy efficient processes. Certain pathways towards decarbonisation rely on more centralised change than others.

Core Demand

The majority of electricity demand within Northern Ireland is underlying demand from domestic customers and I&C customers. Underlying demand refers to all electricity usage relating to existing appliances but excluding electricity demand for the likes of electric vehicle charging. Collectively this underlying demand is referred to as the "core demand" on the network. Future core demand for these two sectors is primarily controlled by two key variables:

- the total number of customers connected to the network which is assumed to be proportional to the size of the building stock, mostly driven by rate of construction of new buildings; and
- the energy intensity of the customers within those properties, mainly driven by energy efficiency of their appliances. It is assumed annual efficiency gains are 1% in both the domestic and I&C sectors.

Figure 14 shows the scenarios for future change in core demand out to 2050 in which core related demand is expected to decrease by 15% in the domestic sector and 21% in the I&C sector.

Figure 14 - Core-Related Electricity Demand in the Domestic and I&C Sectors

Large Industry

The study identified a total of 22 large industrial sites in Northern Ireland, together emitting an estimated 1.1 $MtCO_2$ per year. Fuel consumption in the big industry sector is estimated at 4 TWh consuming mostly natural gas, electricity, petroleum, coal and bioenergy.

Fuel switching from fossil-based fuels to low carbon fuels will facilitate the decarbonisation of most, but not all, of Northern Ireland's large industrial sites. There are certain industrial processes which rely on the chemical composition of the fuel. It is assumed that by 2050 most remaining industrial process emissions will be decarbonised through UK wide Carbon Capture and Storage *(CCS)* for Net Zero compliant scenarios.

The overall emissions picture for the three considered scenarios is shown in Figure 15. In all scenarios there is a steep reduction in emissions over the first few years as the electricity grid decarbonises. Reduction continues in the scenarios that rely on very deep electrification. Over the period 2040 to 2045, scenario Worlds C & E which rely on a widespread hydrogen grid, see their annual emissions decrease very steeply, achieving nearly Net Zero by 2050 *(left hand graph)*. However, cumulative emissions from 2020 to 2050 show that scenario Worlds B & D with deeper electrification, where decarbonisation occurs earlier, also achieve a lower level of total emissions.

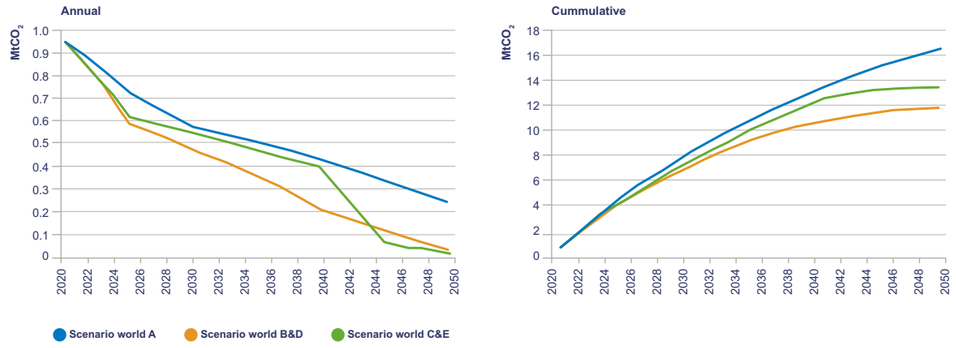


Figure 15 - Annual and Cumulative Carbon Emissions from Big Industry

4.2 ENERGY EFFICIENCY FIRST

Energy efficiency is a key driver in multiple policies to reduce greenhouse gas emissions and is a vital strategy to reach Net Zero. One of the three key targets of the EU's 2030 Climate and Energy Framework is a 27% improvement in energy efficiency. It is also one of seven 2050 EU long term strategy building blocks.

In the document 'Powering a climate-neutral economy: An EU Strategy for Energy System Integration[80]', energy efficiency is listed as the first of the three key strategies for energy system integration to provide low carbon, reliant and resource efficient energy as it reduces the overall investment required to achieve carbon neutrality. The other two main pillars of this strategy are electrification and the use of clean fuels, discussed further in Chapter 5.

The energy system as a whole must become 'circular', where less energy intensive options are prioritised and unavoidable waste recycled within the system. Ensuring that unavoidable waste production is usefully converted reduces the burden of energy production on the planet's resources. For example, 29% of industrial energy demand ends up as heat waste which could be repurposed back into the manufacturing process or contribute to a district heating and cooling network.

The CCC has identified that Northern Ireland must take a whole system approach to decarbonisation with energy efficiency as a primary consideration. Efficiency improvement initiatives include better insulated buildings, improving vehicle efficiency and improving industrial process efficiencies.

Three key areas in which energy efficiency can provide clear benefits for both the UK as a whole and Northern Ireland in particular are:

- poor housing stock;
- the cost of energy; and
- the need to use less.

4.2.1 Poor Housing Stock

The UK has some of the oldest and least energy efficient homes in Europe and as a result, domestic dwellings contribute up to 17% of the UK's annual emissions[81]. Emissions from UK buildings as a whole have fallen by 17% *(18 $MtCO_2$)* over the last thirty years[82] and by 25% since the 2001 peak as a result of a range of actions including: the improvement of energy performance of homes, implementation of new efficiency standards for gas boilers, the widespread adoption of LED lighting in homes and in street lighting, raising minimum standards for new and existing buildings and minimum energy performance standards for private rented properties.

Despite this progress, around 16 million homes in England *(66%)* are at EPC D or worse[83] and private rental homes only require a standard energy performance of Band E at the point of rental. Similarly, in Northern Ireland, 67% of homes are rated at EPC D or worse, as illustrated in the pie chart below[84].

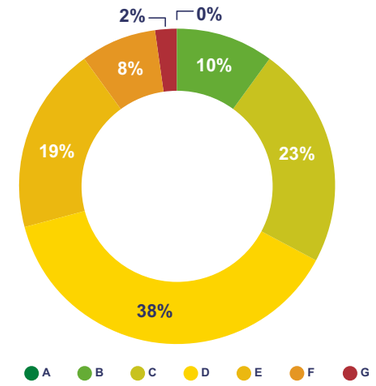


Figure 16 - Northern Ireland Domestic Properties EPC Ratings

The CCC has recommended energy efficiency improvements in over half of existing homes in the UK by 2035. This will likely require a national investment programme costing an average of £10,000 per home over a 30-year period[85]. It is estimated that investment in the efficiency of buildings across the UK could save up to 71 $MtCO_2e$ between 2023 and 2032. This is equivalent to 16% of the UK's emissions in 2018. Additionally, the 6th Carbon Budget recommends that all new buildings are zero carbon by 2025 at the latest[86].

Future Homes Standard

To increase the efficiency of new builds and avoid the need to retro-fit properties at high cost, the UK government has proposed The Future Homes Standard due to be introduced before 2025 and which should also be replicated in Northern Ireland. Homes built to this standard will produce 75 – 80% fewer carbon emissions than houses built to current standards. This has the potential to benefit customers while contributing to Net Zero energy targets as the annual energy cost of a Band C home can be up to £750 less than a Band E rated home[87].

The Use of Fossil Fuels

To get to Net Zero, natural gas must be phased out either by repurposing the gas grid to use biomethane or hydrogen, or moving to other low carbon heat sources such as heat pumps. Oil boilers must also be phased out via a ban on their installation by certain dates. The average boiler has a life expectancy of 15 years providing opportunity in the early 2030s to convert systems currently being installed to a low carbon alternative. Figure 7 shows that in Northern Ireland, 24% of properties are connected to the gas network[88] in comparison to 85% of domestic properties in England, with 68% of homes in Northern Ireland supplied by oil.

Wider Benefits

A research report[90], commissioned by the DfE, has highlighted the range of economic and wider societal benefits that can be achieved by significantly improving how we use energy, while demonstrating that there is a need for a dramatic shift in the scale and pace of energy efficiency roll-out in order to meet the target of achieving Net Zero carbon by 2050. This will need a blend of policy levers, significant investment and appropriate policy to implement. The Economy Minister states that "The first step in decarbonising our energy mix is to actually use less energy for our power, heating and transport needs" and acknowledged that the actions and initiatives in the report point the way to benefits for everyone[91]. The report suggests that Northern Ireland requires a significant building retrofit programme.

4.2.2 Cost of Energy

The transition away from fossil fuels across various sectors such as transport, heating and industry will result in a large increase in alternative energy requirements. However, when coupled with energy efficiency gains the cost of energy can be kept to a minimum. The UK government is also seeking to improve the energy efficiency standards of household products via an energy related products policy framework. Intervention of this kind is intended to allow households to reduce their bills and contribute positively to energy targets with minimal effort. The framework also aims to encourage customers to consider the full energy lifecycle of their appliances and the effect of its carbon footprint on the environment.

The increased penetration of smart technologies such as smart meters and smart appliances can help customers to manage their energy usage e.g. as pre-setting washing machines and electric vehicles to use electricity at times of low demand when the electricity price could potentially be lower. These initiatives have great potential to help offset the cost of increased energy usage due to adoption of LCTs and increase the participation and awareness of individual customers in meeting climate targets.

Across the UK, the dual fuel energy bill for an average household in 2019 was similar to that in 2010 with a reduction on average of £30-£40 per annum. Increases in the efficiencies of household appliances represent one of the most cost-effective ways to reduce both energy bills and carbon emissions.

4.2.3 Need to Use Less

In the UK and Northern Ireland to date, the power sector has been the primary contributor to the reduction in emissions due to efficiency measures.

The Sixth Carbon Budget[92] has modelled a number of scenarios to understand how the UK can achieve Net Zero by 2050. In all scenarios, over 15% of abatement measures rely on customers to improve efficiency and reduce demand. In more ambitious scenarios this increases to 19% of abatement. Electric vehicles and heat pumps are circa three times more efficient than conventional power trains and heating systems. As customer uptake of these increases, demand for fossil fuels such as oil and gas will fall more rapidly than the increase in electricity consumption. The electrification of demand in combination with a circular energy system could cut the demand for primary energy in Northern Ireland by as much as 44% by 2050 compared to today as shown in Figure 17[93].

To summarise, the energy-efficiency-first principle has the potential to provide widespread benefits such as the integration of the energy system to reuse waste, reduce consumption and customer bills and take full advantage of resources.

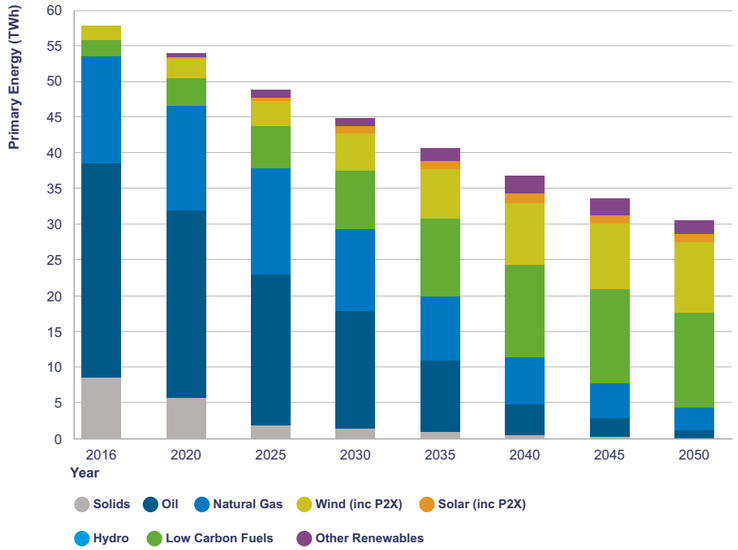


Figure 17 - Primary Energy mix for Northern Ireland – TES – Addressing Climate Change scenario

4.3 PATHWAYS

There are a host of LCTs available to the customer today and as markets mature more will become available. The following paragraphs describes the anticipated uptake of LCTs available to domestic households and industry.

4.3.1 LCT Uptakes

Electric Vehicles

The uptake scenarios modelled considered low carbon powertrains across the main transport segments: cars, vans, heavy goods vehicles *(HGVs)*, buses, minibuses, coaches, and motorcycles / 2-wheelers. In the short term, UK scenarios are scaled based on local historic data for EV uptake to accurately reflect the uptake of EVs in Northern Ireland. In the long term the scenario is blended towards an EV distribution based on the current number of cars in Northern Ireland vs. UK to reflect the likely distribution of EVs for high uptake levels.

Table 3[94] summarises the policy objectives relating to internal combustion engines *(ICEs)* which drive the analysis in each scenario World as outlined in 4.1.2 and Table 2.

World	EV Scenario	Decarbonisation Ambition	EV Proportion of Car Sales in 2030
	Low	Government fails to achieve previous ambition of 2040 end of sales for Internal Combustion Engines *(ICEs)*	30%
A	Medium	Consistent with Governments previous ambition of end of sales for ICEs by 2040	48%
B & C	High	Consistent with the CCC's previous 'Net Zero' recommendation for end of sales for ICEs by 2035[95]	72%
D & E	Very High	Consistent with Governments current ambition of end of sales for ICEs by 2030[96]	100%

Table 3 - Summary of Policy Objectives

Figure 18 below shows the predicted uptake results for each scenario world relating to cars and vans.

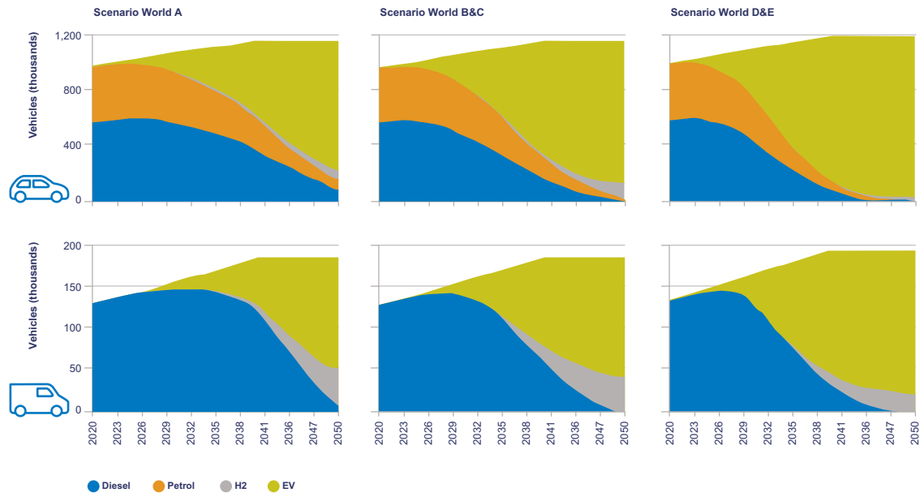


Figure 18 - Uptake scenarios for cars and vans

Figure 19 shows the predicted uptakes of electric vehicles in comparison to the total vehicle stock in Northern Ireland out to 2050. Total vehicle stock (including electric and conventional powertrains) is expected to increase to 2040 then plateau as the market reaches saturation. The scenarios achieve between 400,000 and 1.3 million EVs in operation in Northern Ireland by 2050 with the very high uptake scenario *(worlds D and E)* achieving almost complete electrification of cars and vans. The UK Governments present position on banning the ICE by 2030 is represented by the 'Very High' uptake scenario modelled which would indicate that by 2030 almost 1 in 3 cars and vans in Northern Ireland could be electric.

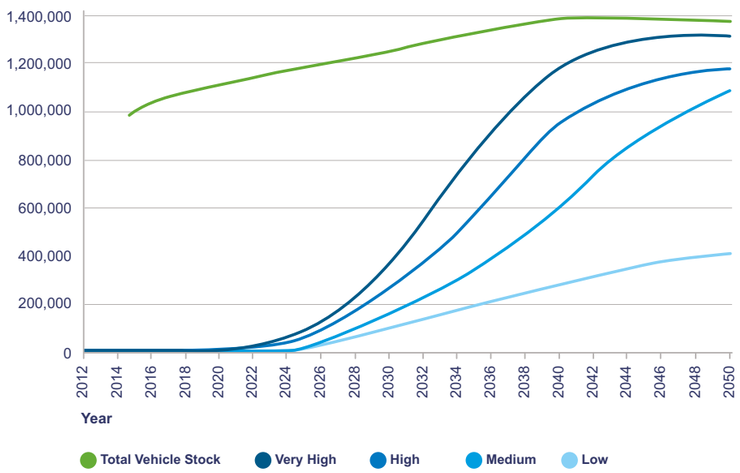


Figure 19 - Total Number of EVs (cars & vans) in Northern Ireland By Scenario

The uptake scenarios presented will lead to a significant reduction in GHG emissions. Electricity is the dominant powertrain for vehicles in 2050 for all scenarios and thus emissions from the road transport sector depend heavily on the electricity grid carbon intensity.

Figure 20 shows the evolution of transport emissions until 2050 for each of the different scenario Worlds. All scenario worlds show rapid reduction in emissions and scenario Worlds B, C, D and E have extremely low emissions in 2050.

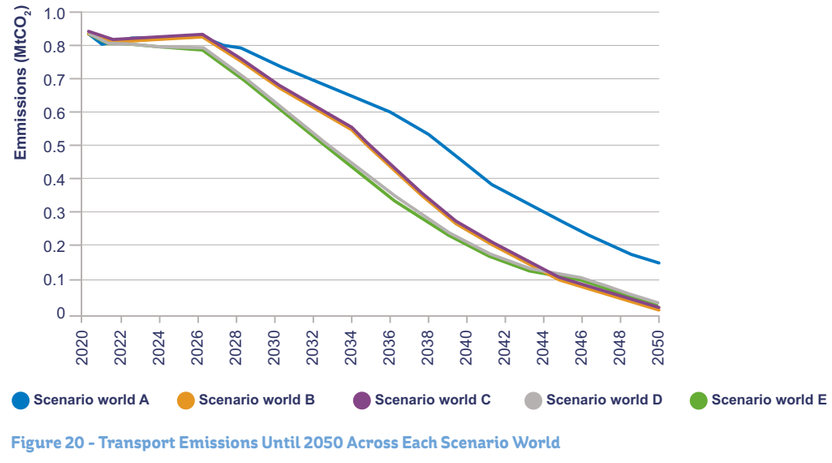


Figure 20 - Transport Emissions Until 2050 Across Each Scenario World

Heating

The modelling considered two main pathways to decarbonise heat in Northern Ireland, each relying on varying levels of electrification and gas decarbonisation. A high electrification scenario corresponds to a high uptake of heat pumps where most heat is electrified, and the gas grid would effectively be decommissioned by 2050. This approach would result in the most significant demand impact on the electricity network. By contrast, a high decarbonised gas scenario promotes the conversion of the gas grid to hydrogen in the early 2040s and heating becomes predominately gas *(hydrogen)* boilers.

Uptake scenarios were developed for individual building-level heating technologies using a consumer choice uptake model[97]. Table 4 summarises the assumptions assigned to each scenario World.

World	Heating Scenario	Compliant with Net Zero by 2050?	Heat Pump Deployment	Gas Grid Composition by 2050
	Low Electrification	No	Low	Natural Gas Available to 550,000 customers
C & E	Low Electrification and Decarbonised Gas	Yes	Medium	Post 2040: Hydrogen and other Low Carbon Gases Available to 550,000 customers
A	Medium Electrification	No (unless gas grid is decarbonised)	Medium	Mainly Natural Gas with some Biogas Available to 550,000 customers
B & D	High Electrification	Yes	High	Mainly Natural Gas with some some Biogas Decommissioned by 2050

Table 4 - Heating Scenario Input Assumptions

Figure 21– Figure 23 summarise the resultant heating technology breakdown for each scenario world based on the assumptions above.

Low Electrification – Worlds C and E

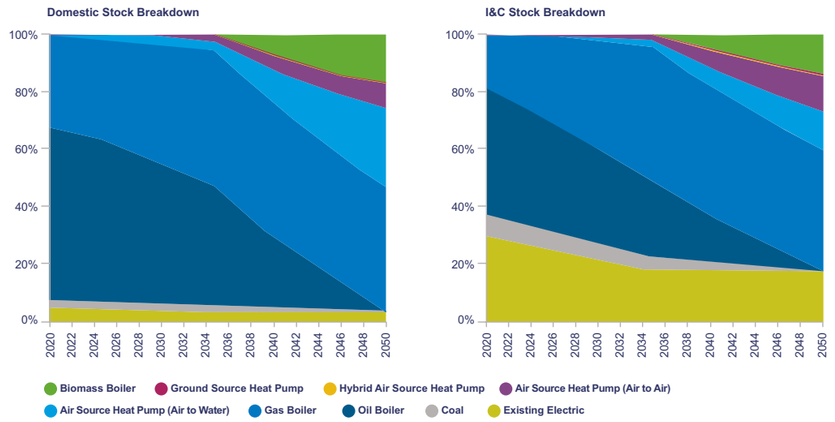


Figure 21 - Breakdown of Heat Technologies in the Low Electrification Scenario

In the low electrification with decarbonised gas scenario, there are no new builds with gas from 2025 and existing buildings cannot access gas from 2040. The gas grid is repurposed to distribute hydrogen in 2040 and all gas boilers switch to hydrogen boilers. There are no new builds with oil from 2025 and existing buildings cannot access oil from 2035.

Medium Electrification – World A

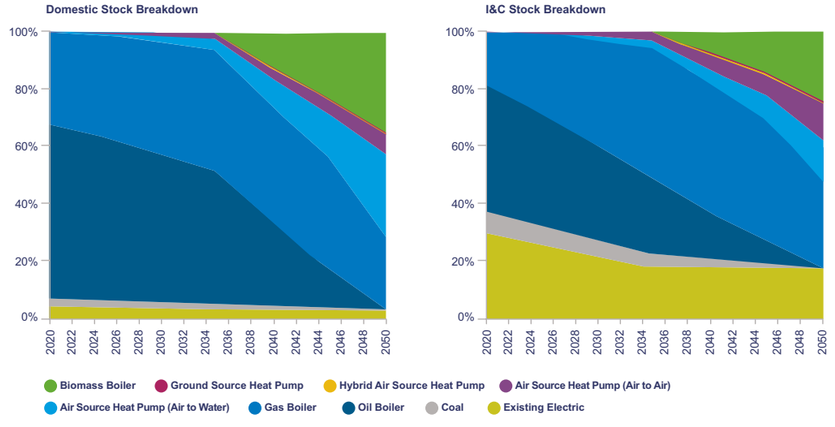


Figure 22 - Breakdown of Heat Technologies in the Medium Electrification Scenario

In the medium electrification scenario, there are no new builds with gas from 2025 and existing buildings cannot access gas from 2045. There are no new builds with oil from 2025 and existing buildings cannot access oil from 2035. Significant uptake of heat pumps is delayed until 2040 and the use of biomass boilers increases.

High Electrification – Worlds B and D

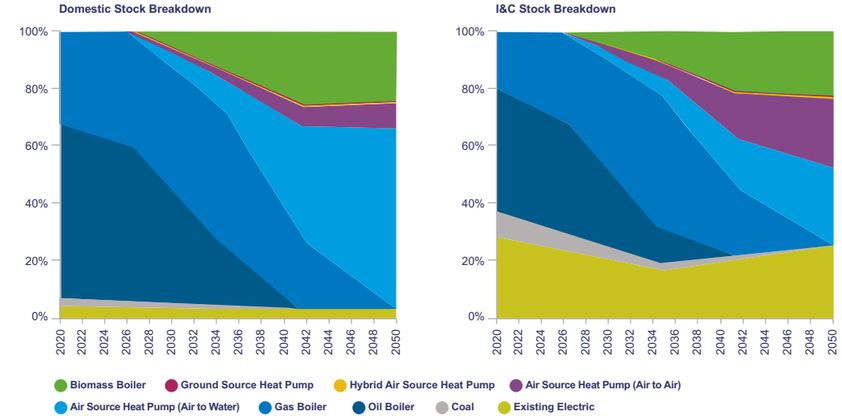


Figure 23 - Breakdown of Heat Technologies in the High Electrification Scenario

In the high electrification scenario, over 75% of domestic stock will be electrified. There are no new builds with gas from 2025 and existing buildings cannot access gas from 2035. The gas grid is decommissioned by 2050. There are no new builds with oil from 2025 and existing buildings cannot access oil from 2027.

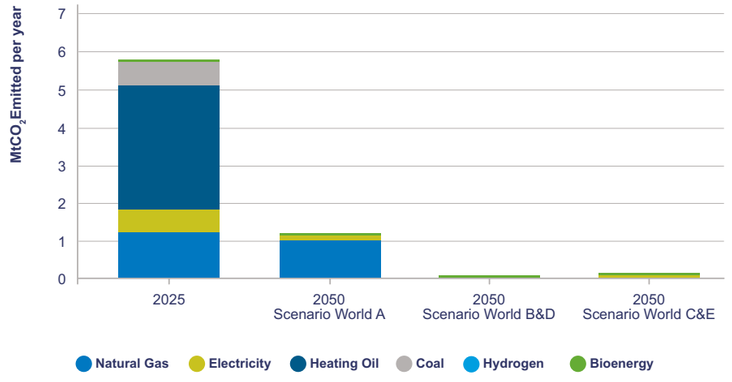


Figure 24 - Annual Carbon Emissions from Building-Level Heat

The energy efficiency, stock growth and heating technology elements were then used to calculate energy consumption and fuel mix for each scenario out to 2050. These factors were then used to determine the resultant emissions as shown in Figure 24. Emissions reduce from 5.7 $MtCO_2$ to 0.06 $MtCO_2$ in the Net Zero compliant scenarios *(Worlds, B, C, D and E)*.

Solar Photovoltaic (PV)

The modelling assumes that Solar PV uptake is market driven with no specific policy incentives to stimulate uptake apart from a Smart Export Guarantee[98] *(SEG)*. The uptake model assesses customer willingness to pay for the technology which is influenced by factors including the electricity price and capital costs of installation. Table 5 provides a summary of the key factors influencing uptake.

The model also assumes that installations smaller than 5MW have a lifetime of 15 – 25 years before they require full replacement. For installations greater than 5MW, it is assumed that they are repowered with the latest technology to extend their operational lifetime and therefore do not require replacement for a much longer period of time.

Uptake Scenario	Electricity Price for Export to grid	Capital Investment	Policy Mechanisms
Low	Low	High	SEG set at GB wholesale price for 2020
Medium	Central	Medium	SEG is same as PowerNI Microgen export tariff
High	High	Low	SEG is 10% higher than PowerNI Microgen rate

Table 5 - Summary of Solar PV Modelling Assumptions

Figure 25 - Figure 27 below summarise the roll out for micro PV *(<4kW)*, small scale PV *(4kW – 5MW)* and large-scale PV *(>5MW)* out to 2050.

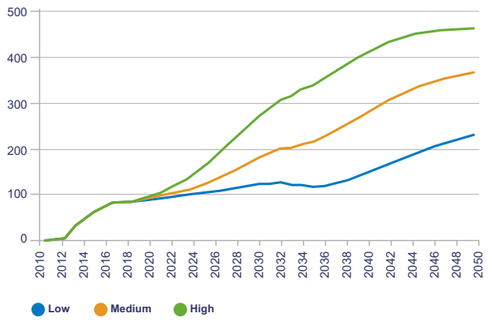


Figure 25 - Micro PV Uptake Rates

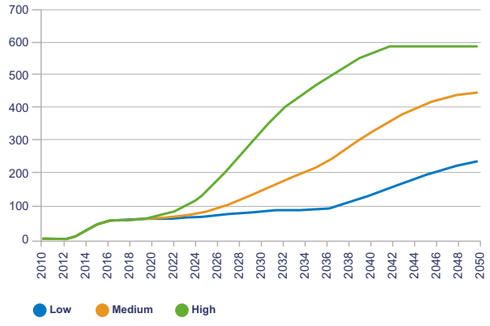


Figure 26 - Small Scale PV Uptake Rates

Micro PV mainly focusses on household installations where the low uptake scenario results in a delay in the number of installations, reaching just under 250MW, whilst the medium uptake scenario increases to 450MW installed capacity by 2050. The high uptake scenario increases rapidly to slightly below 600MW, before levelling off after 2040

Small scale PV relates to technologies that could be installed at small businesses, farms, or in industrial premises. Each Small Scale PV uptake scenario follows significant growth out to 2050, with the possibility of 240MW with low uptake, 370MW with medium uptake and 460MW of installed capacity for a high uptake scenario by 2050.

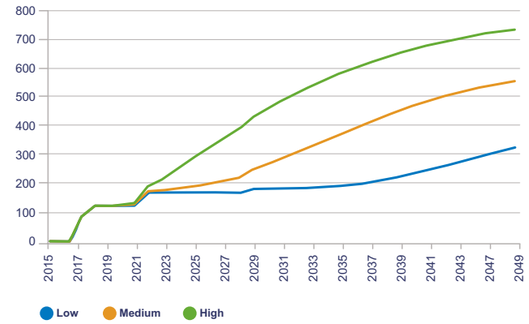


Figure 27 - Large Scale PV Uptake Rates

The large-scale PV installations are more likely to be representative of large-scale PV projects connected to the distribution or transmission grid where the power output is sold into the wholesale electricity market. Large Scale PV in a high uptake scenario increases quickly, and may have an installed capacity of roughly 750MW by 2050. The medium uptake scenario may reach 550MW by 2050. In contrast, the low uptake scenario highlights a delay in the initial uptake, with installed capacity only beginning to show a significant increase by 2037.

Storage Uptake – Domestic

Domestic storage was modelled as a 'solar PV + storage option'. Domestic customers *(solar PV up to 4kW)* could choose to buy a solar PV system only or a solar PV system with storage.

A product availability parameter was used to restrict the number of customers that could choose the solar PV system with storage in a given year. Product availability was gradually phased to 100% over 8 – 9 years. Table 6 provides an overview of the battery technology cost and deployment assumptions used for each scenario.

Scenario	Battery Pack Costs	Installation Costs	Product Availability, 100% By Year
Low	High	60% of Battery Cost	2029
Medium	Medium	40% of Battery Cost	2028
High	Low	20% of Battery Cost	2027

Table 6 - Summary of Element Energy Battery Assumptions

Figure 28 shows that across all uptake scenarios there could be between 30 – 150MW of domestic batteries installed by 2050.

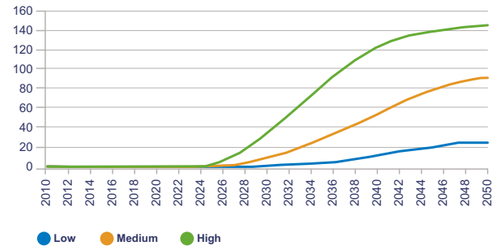


Figure 28 - Deployment Curves for Domestic Storage by MW Installed

Storage Uptake – Industrial and Commercial

Industrial and commercial operations are commercially aware and are driven by cost competitiveness, so that businesses remain profitable going forward. Storage uptake for these sectors is considered an investment, where the technology is often "behind-the-meter" and was modelled using following assumptions:

- Based on a willingness to pay approach;
- Uptake of installed capacity per year; and
- Payback periods.

Figure 29 provides an illustration of the various uptake scenarios. Uptake reaches 0.45%, 20%, and 45% of total capacity for Low, Medium and High scenarios, respectively, by 2050. The uptake in 2030 is 0MW, 8MW, and 37MW based on the Low, Medium and High trajectories.

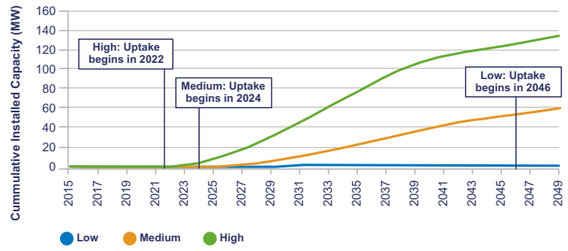


Figure 29 - Industry and Commercial Behind-the-Meter Uptake (MW Installed Capacity)

4.4 MODELLING FINDINGS

The analysis shows that in four of the five scenarios modelled, Northern Ireland can achieve the level of decarbonisation recommended by the CCC to achieve Net Zero in the UK by 2050.

To support the level of RES required for each of the scenarios, greater system flexibility must be promoted in the coming years. This flexibility will provide support in areas such as demand side management which along with government incentives and policy, will allow customers to actively manage their energy consumption. The added benefit to customers is the potential to decrease their bills and an increased engagement with the changes needed to the energy system to facilitate Net Zero targets.

Increased Electrification

The path to decarbonisation includes a steep increase in the uptake of LCTs such as electric vehicles and heat pumps resulting in an increased demand on the electricity network. Figure 30[99] indicates that this may materialise in an increase in electricity usage from around 17% in 2020 to around 23% - 27% by 2030 across the 3 TESNI scenarios *(ref Table 2)*.

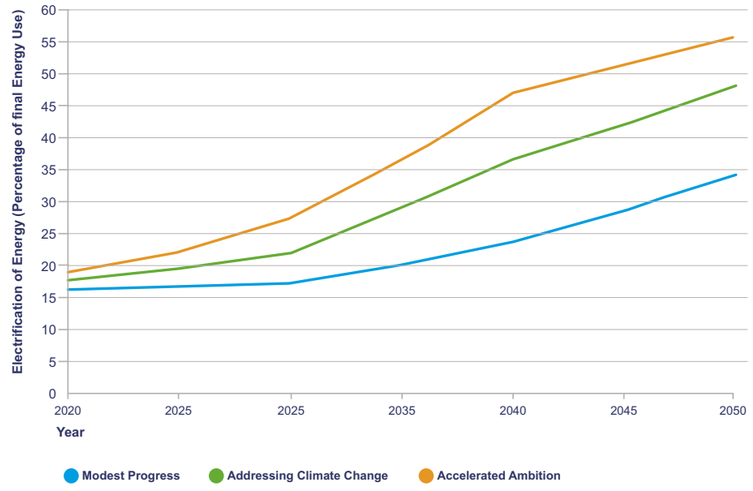


Figure 30 - Electrification of Energy in each SONI TES Scenario World

Primary Energy

Despite increased electricity usage from the increased penetration of renewables and LCTs, higher efficiency gains over the coming years shall cause total primary energy usage in Northern Ireland to fall by 44% by 2050 in comparison to 2020 levels *(See Figure 17)*. In the JWG Addressing Climate Change scenario, only 15% of total primary energy is sourced from fossil fuels by 2050.

Electricity Consumption

In the NIE Networks / SONI JWG analysis, the high electrification in demand could increase by between 50% and 70% by 2050 in the 2 decarbonisation pathways *(Figure 31[100])*.

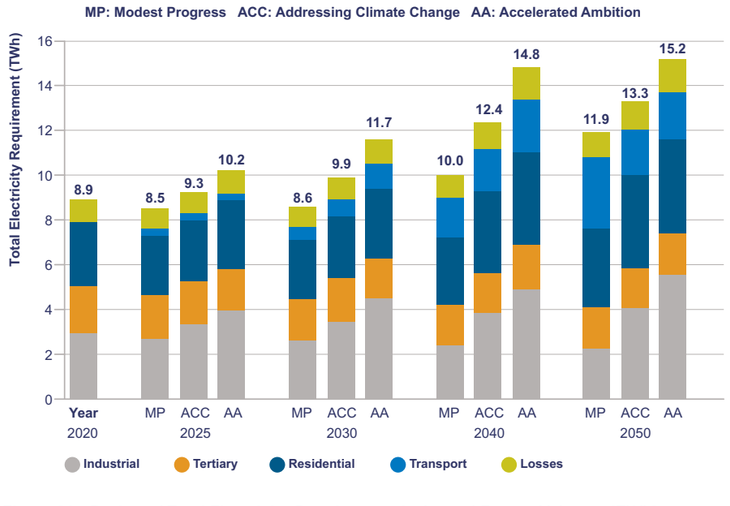


Figure 31 – Projected Total Electricity Requirement in Annual Energy Volumes (TWh)

Emission Reductions

Referring to the Element Energy scenarios and the NIE Networks / SONI JWG analysis *(as summarised in Table 2)*, the analysis shows that in four of the five scenarios modelled by Element Energy *(Worlds B, C, D, E)* and in the Achieving Climate Change and Accelerated Ambition scenarios in the SONI TESNI and JWG reports, Northern Ireland can achieve the level of emissions reductions recommended by the Committee on Climate Change to achieve its UK Net Zero commitments by 2050.

Emissions are expected to fall considerably in all scenarios over the coming decade due to three main factors:

- Increasingly decarbonised electricity grid via connection of additional renewable generation;
- Energy efficiency measures continue to be rolled out, especially thermal measures in building stock; and
- Prevalence of oil decreases due to electrification and changeovers to low carbon gas.

Figure 32 below demonstrates that in the most ambitious scenario *(Accelerated Ambition in yellow)*, the set of inputs pathways selected would decarbonise much more rapidly and largely meets 2050 commitments on emissions by 2040. whereas the Addressing Climate Change trajectory in green follows closely the level of decarbonisation that Northern Ireland should achieve under the recommendations set out by the Committee on Climate Change for a Net Zero UK by 2050 *(dark blue line)*.

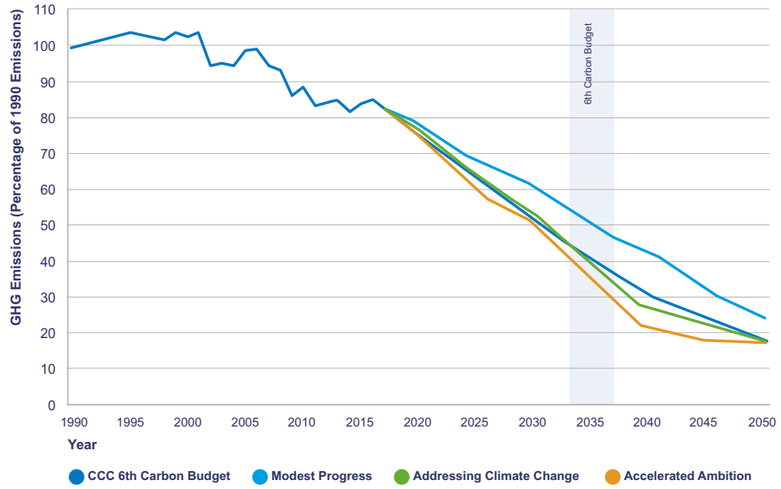


Figure 32 - GHG Emissions for Each JWG Scenario World as Percentage of 1990 Emissions

Northern Ireland Electricity Networks

5. AN INTEGRATED ENERGY SYSTEM

CHAPTER 5 – AN INTEGRATED ENERGY SYSTEM

- **Role of Electrification in Northern Ireland's Decarbonisation Strategy** – NIE Networks considers that energy strategy should follow the principals of energy efficiency first, direct electrification where possible followed by other zero and low carbon solutions such as biomass, biogas, hydrogen and natural gas with carbon capture and storage.
- **Transport** – All cars and light duty vehicles should transition to battery electric vehicles. NIE Networks modelling work has assessed that there could be 400,000 electric vehicles *(one in three)* by 2030.
- Northern Ireland's EV charge point infrastructure is half the UK average. This has impacted in the slower uptake of EVs in Northern Ireland. The UK Government released a vision for high powered *(150 - 350kW)*, open access EV charging infrastructure at motorway services across England. A similar programme will be required in Northern Ireland.
- NIE Networks has advocated locally for a Northern Ireland Cross-Departmental Government EV Taskforce to be convened by the DfI, involving the DfE. This taskforce would explore how best to set and move forward with Northern Ireland's EV ambitions, including charging infrastructure provision and business models for operators.
- **Buildings** – Northern Ireland needs an expansive energy efficiency upgrade programme which greatly improves the fabric of domestic and commercial buildings thereby reducing their energy demand. It is suggested that a programme of 50,000 homes annually over the next decade is required.
- More than 26 million heat pumps are envisaged in the UK by 2050. Direct electrification via heat pumps produce four to five times more heat per unit of wind / solar than could be delivered via a hydrogen boiler supplied with hydrogen from renewable sources. The heat pump / hybrid market requires to be encouraged and developed in Northern Ireland and a programme commenced initially for new and off gas grid homes.
- Building regulations should ensure that new and substantially renovated domestic and commercial buildings have a high level of insulation. New buildings should not have fossil fuel boilers installed to avoid being locked into a prolonged period of high carbon emissions.
- **Industry** – Decarbonising industry is seen as a difficult part of the energy transition. This is due to the long-life cycles of heavy industrial equipment and the specific characteristics of that local industry. Northern Ireland does not have the scale of heavy industry as in other parts of the UK but dairy farming and public services *(e.g. Combined Heat and Power in hospitals)* have high energy demands. Direct electrification can play a considerable role in industry and in processes with very high temperatures the solutions could be biomass, green gas or hydrogen.
- **The Role of Non-Direct Electrification**
- Hydrogen – There are undoubted opportunities for Northern Ireland to produce hydrogen from renewable sources of electricity however using surplus wind energy has its challenges in terms of economic production. NIE Networks suggests that the role for hydrogen end use will be primarily in heavy industry, in decarbonisation of the power system and possibly in heavy vehicles / coach road transport and rail. Use of hydrogen in a repurposed gas network for mass rollout requires a proven technical and economic case and the 2020s should be used as a period of trial as in GB to determine the economic case and possibilities. Until then further extension of the gas grid should be viewed with caution as it may not be in the best interests of the Northern Ireland customer. Bioenergy has attributes but it is scarce due to a lack of underlying resources and there are concerns over its sustainability.
- Power generation and heavy industry could use natural gas with post combustion CCS to decarbonise. CCS opportunities in Northern Ireland should be explored but it is likely this will be considered in an overall UK context.
- **In Summary:**
  - Electricity decarbonisation in production / supply is proven and well on course and the power sector could be the first to decarbonise ahead of 2050;
  - Electricity is a well understood, controllable source of energy backed up by a robust and resilient electricity network;
  - With higher energy efficiency gains and a switch to electrification for heating and transport, the total primary energy requirements fall by almost half by 2050 compared to today; and
  - There will be a wide variety of opportunities for customers to engage in their energy management

5.1 ROLE OF ELECTRIFICATION IN NORTHERN IRELAND'S DECARBONISATION STRATEGY

When developing plans for how we will decarbonise Northern Ireland we must consider every energy application or use case and make informed decisions on what is the best decarbonisation technology. There is significant evidence available through sources like the CCC, but ultimately, we need a bespoke decarbonisation strategy that fits with our specific parameters and characteristics in Northern Ireland. However, Northern Ireland cannot ignore the policies and expert advice which is prevalent in the UK and Europe and must learn from experiences and emerging strategies elsewhere. These approaches and policies must be adopted for a Northern Ireland context and actions expedited in the areas where current technologies permit.

Northern Ireland's energy strategy should follow the generally held principal of a hierarchy of decarbonisation priorities established as **energy efficiency** first, **direct electrification** next where possible followed by **other zero and low carbon solutions** such as biomass, biogas, hydrogen and natural gas with carbon capture and storage. This hierarchy runs strongly through the CCC's Sixth Carbon Budget advice[101] and is also set out explicitly in the European Commission's System Integration Strategy EU COM 299 published in 2020[102].

In the sections below, we identify specific energy use applications and the vital role that electrification can play.

5.1.1 Transport

Transport represents more than 20% of Northern Ireland's GHG emissions and around 30% of final energy demand. Moreover, the energy used in transport is mostly imported. Decarbonising transport through electrification offers an opportunity to reduce emissions while at the same time greatly reducing imported fuel dependency. Decarbonising transport strategy should commence with encouragement to more active travel solutions *(walking, cycling)* and the increased use of public transport. There will still be a requirement for road vehicles and electrification has emerged as the first choice when decarbonising these especially in the car and van sector.

Applying the CCC approach from the Sixth Carbon Budget Balanced Pathway the following decarbonisation approach would be most appropriate:

- All cars and light duty vehicles transition to Battery Electric Vehicles (BEV). There would appear to be little ambiguity or uncertainty on this point. BEV's are much more efficient than ICE or fuel cell Vehicles and increasingly more electric models are being added by manufacturers each year while battery costs are coming down[103]. The CCC recommends that the move to 100% BEV sales should be complete by 2035 so there is much to be done to have the enabling conditions for this in place in Northern Ireland.
- Electricity will also play a significant role in heavier vehicles. The CCC projects circa 40% penetration of BEVs in new heavy-duty vehicles by 2035 in the Balanced Pathway based on input from Element Energy. They state that penetration levels above this will be down to how the ongoing battle of economics and technology concludes between BEVs and hydrogen. If BEV technology continues to develop as it has done, 2050 could see non-BEV vehicles in just a few applications like longer journey coaches and very heavy transport. It is interesting to note that some longer distance haulage vehicle manufacturers have switched their strategy from hydrogen to BEV recently. Volkswagen-owned Scania, which has produced both battery and hydrogen-powered vehicles, has concluded that hydrogen will be too inefficient and expensive for long-distance transport[104].

Given the above, NIE Networks is strongly of the view that Northern Ireland's decarbonisation strategy for transport should be built around electricity and BEVs. Based on the CCC work, close to 95% of Northern Ireland vehicles, by number, should be BEV in 2050. This is also consistent with Element Energy's assessment for Northern Ireland *(see Chapter 4)*. There is an immediate requirement to put the enabling infrastructure in place for this. This will involve ensuring adequate charging infrastructure is in place for public charging and that the distribution networks are readied for the nature of the new load that will come forward. Northern Ireland should also be proactive in investigating the application of vehicle to grid technology and the requirements that might be required for smart charging.

EV Charging Infrastructure in Northern Ireland

The current network of public EV Charge points in Northern Ireland was largely installed in the period 2012-2014, with most of the initial funding provided through grants from the Office of Low Emission Vehicles *("Plugged in Places"*

Programme). Although this provided three times more charging points per head of population than the UK average at that time, the absence of further investment has resulted in Northern Ireland's EV charge point infrastructure rapidly declining to half the UK average. This is reflected in the slower uptake of EVs in Northern Ireland, due in part to 'range anxiety' and the lack of visible infrastructure investment.

There are currently only around 4,000 electric vehicles in Northern Ireland and more than half of these are plug in hybrid electric vehicles which are likely to use the public charge point network on a limited basis. The high investment cost and much smaller market relative to other UK jurisdictions creates a difficult business case, discouraging new entrants to compete in the public EV charging market.

As the number of home chargers increases, additional investment in the electricity network will be required to cater for the additional load. NIE Networks can undertake that investment, subject to appropriate regulatory support and an appropriate investment recovery mechanism.

With regards to Public Charging, investment will need to be incentivised by appropriate and clear funding mechanisms. The recent announcement of €6.4m/£5.8m EU Interreg funding for a network of 73 rapid charging points across Northern Ireland, RoI and Scotland is a positive and welcome development although it is not yet clear how this will be specifically applied to Northern Ireland.

In May 2020 the UK Government released a vision for high powered *(150 - 350kW)*, open access EV charging infrastructure at motorway services across England under the Project Rapid programme. A similar programme will be required in Northern Ireland to ensure that there is a rapid-charging network ready to meet the long-term customer demand for electric vehicle charge points ahead of need. NIE Networks has advocated locally for a Northern Ireland Cross-Departmental Government EV Taskforce to be convened by the Department for Infrastructure (DfI), involving the DfE. This taskforce would explore how best to set and move forward with Northern Ireland's EV ambitions, including charging infrastructure provision.

NIE Networks' primary role in this area is to ensure the electricity network can support the expected growth in electric vehicles and to connect EV charging infrastructure to the electricity network. NIE Networks is also willing to finance and deliver public EV charging infrastructure itself *(or in partnership with others)* subject to a regulatory recovery mechanism, if that is the optimal policy option identified. Whichever funding options are adopted, NIE Networks will work proactively to enable and support the delivery of an effective EV charging infrastructure in Northern Ireland.

5.1.2 Buildings

The recent Sixth Carbon Budget from the CCC foresees significant energy efficiency measures and heat pump penetration in the UK as part of reaching the Net Zero commitment. More than 26 million heat pumps are envisaged by 2050. The CCC advice also foresees electricity based low carbon heating networks as being important, in particular for commercial buildings. Hydrogen is the other heating source envisaged for buildings *(circa 11% in their balanced pathways scenario)* but it is expected to be zoned for places on the gas network near industrial clusters and nearly always in conjunction with heat pumps.

Heat pumps produce circa five times more heat per unit of wind / solar than could be delivered via a hydrogen boiler supplied by green hydrogen. The higher efficiency of renewable power compared to hydrogen makes it the most efficient and preferred heat source. The capital costs of home retrofits for energy efficiency purposes is a concern, requires funding and cannot happen overnight. A strategy that commences with the easy to electrify applications such as new dwellings, provision of biogas or even hydrogen injection and district heating where applicable, will commence the journey and buy some time for:

- heat pump markets and supply chains to develop;
- hydrogen economics and viability assessments to be proven; and
- hydrogen trials and business cases on end-use considerations to be completed.

In line with the CCC Sixth Budget Advice the following pathway for Northern Ireland is a least regrets approach.

- Building regulations should be enhanced to ensure that new and substantially renovated domestic and commercial buildings should have a very high level of insulation and airtightness resulting in them having a low energy requirement.
- New buildings should not have fossil fuel boilers installed in them to avoid the owner being locked into a prolonged period of high carbon emissions. The heat pump market in GB and Ireland is already at a stage which supports high penetration, however, the industry does need that kick start in Northern Ireland which could be afforded by new builds and high efficiency homes off gas grid. Further, there are significant employment opportunities for Northern Ireland technicians in this emerging industry across the UK and Ireland utilising existing skill sets.
- Northern Ireland needs an expansive energy efficiency upgrade programme which greatly improves the fabric of domestic and commercial buildings thereby reducing their energy demand. This will provide local jobs in Northern Ireland while at the same time reducing reliance on fossil fuel imports. The recent report commissioned by the DfE entitled 'Research into the Future of Energy Efficiency in Northern Ireland' concluded that to align with the 2050 Net Zero commitment, policies will be needed to drive retrofitting of more than 50,000 buildings per year in Northern Ireland within the next decade[105], more than treble the current rate. The Economy Minister further stated 'Our local energy efficiency sector has the potential to grow significantly over the coming years, providing skills development and job opportunities'[106].
- Northern Ireland's new energy strategy should consider how low carbon heat networks can be developed as a solution to decarbonising heating in Northern Ireland. The CCC advice envisages these networks as being needed, especially in the commercial sector and they can greatly compliment an electricity system with high levels of variable renewables. Storage of hot water represents one of the cheapest ways to store electricity.
- The new Energy Strategy should put in place a program of work to identify a route to decarbonising buildings on the existing gas grid. Natural gas heating, or even a blended variant, is not compatible with Net Zero and can only be an interim solution. Given the lower carbon content of natural gas than oil, there is merit in sequencing this after addressing off gas grid houses. This work will need to consider the role heat pumps would play in these on gas grid buildings including whether gas would continue to play a role, potentially with hybrid heat pumps. Gas heated buildings must also have energy efficiency measures applied to reduce their total energy demand.
- The pathway for decarbonising gas in Northern Ireland is far from clear. Biomethane is a scarce resource and the technical and economic implications of conversion to hydrogen are only understood at a cursory or abstract level. Northern Ireland already has a significant challenge to decarbonise houses on the gas grid; which highlights the importance of ensuring any consideration of extension is justified and warranted. In the absence of a proven business case for repurposing to zero carbon gas, extending the current mains gas grid could result in a significant economic burden to the Northern Ireland tax payer for generations to come. As per the 2019 CCC advice, buildings off the gas grid should be insulated and have heat pumps installed in preference to any consideration of natural gas extension.

5.1.3 Industry

Decarbonising industry is seen as a difficult part of the energy transition. This is due to numerous reasons including the long-life cycles of heavy industrial equipment. There may be a narrative at play that industry needs very high temperatures and so the solutions will be biomass, green gas or hydrogen. While this is the case for heavy industry such as steel and chemicals production, it is not the case for all industry and so a detailed understanding of the characteristics of local industry is required.

Direct electrification can play a considerable role in decarbonising industry. This can be achieved through part electrification of certain processes and in other areas replacing fossil boilers with heat pump technology where lower temperatures are required. Heat pumps can be used very efficiently in conjunction with waste heat that might already be on a site that would otherwise be discarded. Industrial heat pumps now operate at temperatures up to 160^{o}C with a coefficient of performance of 3 *(300% efficiency)* with research into reaching 280^{o}C. This could in theory allow heat pumps to meet one third of industrial heat demand.

Northern Ireland does not have significant heavy industry but dairy farming and public services have high energy demands *(e.g. Combined Heat and Power in hospitals)*. Given this, the energy strategy should apply an electrification first approach given its superior efficiency compared to other technologies. Gas, decarbonised gas and indeed hydrogen may have a future place in this application, however due to the uncertainties and the outcomes of hydrogen trials in the UK, and the lower roundtrip efficiency cycle, electrification can provide a low carbon solution today and should be a primary consideration.

5.2 THE ROLE OF NON-DIRECT ELECTRIFICATION

There are non-electrification solutions available for decarbonisation which should be pursued where electrification has not been possible. The solutions will include biomass, hydrogen and natural gas with CCS and will be focussed on decarbonising the power system and a few hard to abate areas that can't be directly electrified.

5.2.1 Hydrogen

There has been significant debate and range of opinion about the universe's most common element hydrogen, as a means of decarbonisation and it can undoubtedly play a role sometime in the future, however there remain many unresolved questions about its production, end use and economics which requires clarity.

The Northern Ireland Economy Minister stated in July 2020[107] "We are uniquely placed to use renewable electricity to produce green hydrogen. This would make use of the wind that is available when the demand for electricity is lower *(mainly during the night)* and the wind turbines are switched off".

The potential to produce green hydrogen undoubtedly represents an interesting opportunity for Northern Ireland that should be explored. However, it is not without its challenges particularly in relation to the economic case. The future cost of 'green hydrogen' depends on the costs of renewable electricity which cannot be assumed to be free, the cost of electrolysers, cost of capital and the capacity factor at which plants run. The latter poses questions as to viability if only running a limited number of hours. The economic viability will be determined over time and it is certainly worthwhile to progress trial projects to help assess its viability and establish capability in the shorter term.

On the demand side, hydrogen has the potential for use in industry, transport, power and heating but will need to justify its use in non-traditional sectors on an economic case by case basis. Liebreich sates that 'hydrogen's role in the final energy mix of a future Net Zero emissions world will be to do the things that cannot be done more simply, cheaply and efficiently by the direct use of clean electricity and batteries.[108]' However, there is undoubtedly a demand role for hydrogen.

A report 'Molecules: Indispensable in the Decarbonized Energy Chain[109]' considers the uses of electrons *(electricity)* versus molecules *(specifically hydrogen)* and concludes that 'electricity will become the main energy supplier to deliver energy services to the end consumer' and 'the direct use of hydrogen as a supplier of energy services to the end user is limited'.

Harvesting renewable generation is a key factor in producing green hydrogen for future end use. Electricity can supply most energy demands but when hydrogen is introduced into the cycle, extra conversion steps are required which by the laws of thermodynamics introduces a loss of quality and efficiency[110]. Figure 33[111] below demonstrates this phenomenon and suggests that electricity should be utilised directly where possible. It is always more efficient to make use of electricity directly compared to conversion to hydrogen and re-electrification.

Due to the relative inefficiency of the 'green hydrogen' route, as illustrated in Figure 33, it follows that green hydrogen takes over five times more renewable energy to produce a unit of heat output compared to direct electrification via a heat pump.

Northern Ireland's heating requirement has a high reliance on oil heating *(68%)* and a gas network which is in development. This profile differs significantly from GB and RoI. It is clear that natural gas is not the fuel of the future. However, as an interim step, it makes sense for customers to change from oil to gas boilers where there is a gas network already outside their premises. Any future expansion of the gas network however requires to be compatible in meeting Northern Ireland's and the UK's long-term climate goals. NIE Networks considers that further development of the gas network mains supplies in Northern Ireland may not be in customers best interests and should be viewed with caution until the longer-term decarbonisation strategy for gas has been financially and technically assessed in full. Further expansion of the gas network at this time is *(a)* not compatible with Net Zero absent a long-term economic case, *(b)* is contrary to a generally accepted strategy throughout Europe and indeed emerging in the UK of electrification and (c) could result in potential unnecessary investment in a second energy network.

In GB, the next decade is intended to be a trial period for hydrogen applications by ensuring hydrogen ready boilers are installed in future by 2025, and with a target of 2030 to trial a hydrogen town in GB.

The importance of this advice from the CCC should not be underestimated for Northern Ireland. This direction is not a 'green light' for hydrogen deployment, rather a cautious approach to ensure that decisions taken today are not

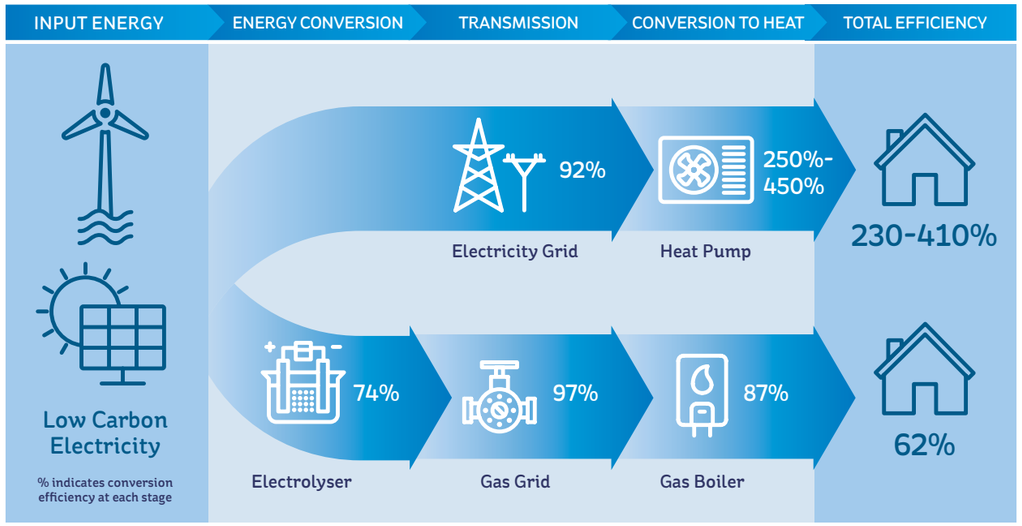


Figure 33 - Relative Efficiency of Heating: Electricity in Heat Pumps vs. Electrolytic Hydrogen in Boilers

setting UK or Northern Ireland on a path of unnecessary public expense from which it will cost dearly to recover from. The fact Northern Ireland has a relatively young gas network should not in itself lead its citizens down a path of a policy where hydrogen is viewed a proven, safe and economically viable solution. An equally cautious approach in Northern Ireland should be adopted which commences with known least regret solutions such as energy efficiency, insulation retrofits, heat pumps for new builds and heat pump / hybrid solutions (heat pumps along with oil or gas boilers) for off gas grid properties. On gas grid properties should have choice.

NIE Networks suggests that the role for hydrogen will be primarily in heavy industry, in decarbonisation of the power system and in heavy vehicles, coach and rail transport. As discussed above, NIE Networks considers that much of current energy demand in heating and transport can be efficiently directly electrified. This will add a significant load to the power system, but it will be able to operate with very high levels of renewable electricity from wind and solar and through interconnections. There will be however, a need for residual dispatchable generation when conditions for intermittent renewable generation are not favourable. Electricity Association of Ireland, an all-island power sector representative body, recently published a report[112] setting out what the power system will look like at 70% renewables in 2030 and what issues are faced in full decarbonisation.

That report shows that a full dispatchable fleet of generation will be required but it will run less and less hours as more renewables come on the system.

Hydrogen through grid connected hydrolysis plant can play a role in providing dispatchable power. It does have challenges such as the ability to store it in large volumes for prolonged periods but there are potential solutions available such as salt cavern storage or further conversion to ammonia.

When considering hydrogen usage, NIE Networks suggests that Northern Ireland's future should be aligned with the use of green hydrogen produced from renewable electricity either dedicated to production or through colocation with existing onshore wind if this is economically viable in the longer term. There are many good reasons for this, including allowing a more modular based approach where more electrolysers can be added as demand increases and the avoidance of huge upfront capital spend on fossil fuel infrastructure and CCS which would be needed with blue hydrogen manufactured from natural gas.

5.2.2 Bioenergy

Bioenergy has many positive attributes not least that it can replace fossil fuels almost directly in many applications. However, it is scarce due to a lack of underlying resources and there are concerns over its sustainability. The CCC has

largely come to this conclusion in its recent advice, as has the European Commission in its Green Deal proposals. The sustainability concerns arise through the production being so resource intensive that it doesn't result in a significant life cycle carbon reduction.

Therefore, bioenergy will be scarce and should be used accordingly. Bioenergy could play a role in agricultural and construction machinery possibly in conjunction with a hybrid battery system. Biomass may also play a role in CHP and heat network applications in conjunction with heat pumps. The energy strategy should ensure that a detailed quantification of bioenergy potential is established for Northern Ireland with a view to understanding where this can be best used.

5.2.3 Natural Gas with CCS

Power generation and heavy industry could use natural gas with post combustion CCS to decarbonise. This process features in the CCC's Sixth Carbon Budget advice and they see the need for some clusters to develop near industrial loads.

This will be a consideration for Northern Ireland especially since it helps to deal with the primary energy storage issues that other solutions bring. However, this solution requires capital intensive carbon capture and storage facilities and a place to deposit the CO_2. It is envisaged that due to geological and economic considerations, CCS will be addressed on a UK basis rather than specific regional strategies to offset local production of CO_2.

5.3 THE BENEFITS OF ENERGY STRATEGY

Power sector and industry decarbonisation is an area what would greatly benefit from more regional co-operation. GB is giving significant consideration to how it will decarbonise its power system and Northern Ireland will have to do this also and with a power system similar to and linked to Ireland's power system. An all-island forum should be established to consider the many complex questions that decarbonisation throws up.

In summary, an energy efficiency led integrated strategy followed by electrification where possible and then other low carbon solutions has the following benefits:

1. Aligns with commonly held principles in the UK / RoI and EU that a strategy of *(a)* Energy Efficiency, *(b)* Electrification and *(c)*, Other low carbon fuels;
2. Electricity decarbonisation in production / supply is proven and well on course. The work undertaken by NIE Networks and SONI shows that in fact the electricity / power sector could be the first to decarbonise ahead of 2050;
3. With a connection into every home and business, electricity is a well understood, controllable source of energy backed up by a robust and resilient electricity network which has been invested in by previous and current customers;
4. In the NIE Networks / SONI modelled scenarios, two of the scenarios modelled demonstrated that a) the electricity sector can decarbonise earlier than 2050 and b) Northern Ireland can meet its obligations under the UK Net Zero ambitions as detailed in the CCCs 6th Carbon Budget *(82% GHG reduction by 2050)*; and
5. With higher energy efficiency gains and a switch to electrification for heating and transport, the total primary energy requirements fall by almost half by 2050 compared to today.

Northern Ireland Electricity Networks

6. EMBRACING THE FUTURE

CHAPTER 6 – EMBRACING THE FUTURE

- **Embracing the Future** – The amount of energy flowing in the distribution network is set to increase significantly with the anticipated high growth in the number of wind generators and increased demand through uptakes in electric vehicles and electrical heat pumps connected to it.
- **The Changing Network** – The distribution network was designed to facilitate the predictable and manageable flow of electrical energy from the transmission network to the customers' premises. However, with power sources such as wind and PV connected to the distribution network, power now also flows in the reverse direction from the distribution network to the transmission network.
- NIE Networks has facilitated the connection of over 20,000 generators to the network enabling the 2020 SEF target of 40% consumption from renewables to be met by summer 2019.
- There is almost 2GW of renewable generation connected with a system peak of 1.8MW and a minimum demand of 0.5GW. With renewable generation and demand expected to increase, there is a significant challenge to develop and operate the network in an efficient manner requiring new innovative methods to continue the safe and secure operation of the network while minimising the cost of the associated network reinforcement.
- **DSO Transition** – As wind power, PV and the commercial arrangements that will permit trading from domestic customers are developed, there will be a requirement to actively manage these power flows to prevent system overloading, to control system voltage and to ensure security of supply and safety. These requirements will drive NIE Networks to develop its role of Distribution System Operator *(DSO)* as well as network owner *(DNO)*. The key elements of the DSO are:
  - Market facilitator: local markets for flexibility and active participation by customers;
  - Service provider: flex existing network assets to provide further services to the TSO;
  - Congestion management: deployment of smart and market-based solutions;
  - Connections: options on how customers connect to the network e.g. flexible connections;
  - Better data provision: to ensure the efficient development and operation of the networks;
  - Network management: Better information to efficiently plan and deliver outages and work;
  - Use of Network Charging: different price structures and tariffs, along with increased time of use pricing.
- The transition will not only benefit active customers through the facilitation of access to markets, but will also benefit all customers through minimising future network costs in the delivery of a low carbon economy.
- The transition to a DSO will deliver whole system and considerable customer benefits. NIE Networks intend to ensure that customers are at the centre of this transition and has engaged with stakeholders throughout this journey.
- **DSO Pathway** – NIE Networks has outlined the evolution of the DSO pathway to 2030 and 2050 against five key enablers:
  - Network visibility – Evolution of NIE Networks' DSO role requires visibility of electrical demand and generation down to the low voltage networks through additional monitoring at substations and customers premises;
  - Network controllability – enhanced control of the network is imperative to facilitate access to third party and DSO markets, optimise utilisation of the network in the most efficient manner and minimise costs to customers;
  - Customer & commercial – Information about network capacity, energy management and access to dynamic tariffs will ensure customers have control over their energy future;
  - Market operability – ensuring customer energy needs are met by providing access to a range of emerging markets, including DSO markets;
  - Systems & data – Development of internal IT, communications infrastructure and systems for data storage, analytics, provision and security are pre-requisite for both customers and the DSO.
- **Customer Benefits** – it is the intention of NIE Networks that customers are at the centre of this DSO evolution and ultimately the success of the transition will be measured according to what benefits it can bring for customers, such as:
  - facilitation of access to markets, but will also benefit all customers through minimising future network costs;
  - customers can extract maximum value from their assets through accessing a range of markets;
  - provision of services to the TSO from the distribution network will be least cost solution for the customer;
  - streamlining the connection process for micro-generation and storage. Flexible connections will enable the connection of further renewable generation customers at a lower cost;
  - providing enhanced forecasting data to the TSO is likely to reduce system balancing costs, again benefitting all customers;
  - Improving network management will reduce generation constraints; and
  - review of the network pricing structure will ensure that costs are recovered in a fair manner across all customer groups.

6.1 THE CHANGING NETWORK

NIE Networks is responsible for the ownership, maintenance and operation of the distribution network and for the ownership and maintenance of the transmission network which is operated by SONI in its role as TSO.

About NIE Networks	
895,000 customers	2,200km of transmission network
47,000 km of distribution network	300 major substations
Invest over £100 million annually in maintaining and upgrading the electricity network	
9,000 new customers are connected to the electricity network each year	
Over 3 million meter reading visits to customer premises annually	

Table 7 - NIE Network Statistics

Historically power flows on the Northern Ireland electricity network have been predictable and manageable, with large centralised generation connected at higher voltage levels supplying end users at lower voltage levels, resulting in unidirectional power flows from generation to supply. The distribution network was designed to efficiently facilitate this flow of electrical energy to the customer. Customers were largely passive in their behaviour which allowed the network to be designed in accordance with their anticipated behaviour which was based purely on electricity consumption from the grid. The diversity of customers' electrical demands allowed networks to be designed in order to ensure the most efficient utilisation of assets as individual customer's behaviours differed and demands peaked at different times.

However, the decarbonisation of the energy sector has caused significant changes in the electricity industry which are challenging the historic design and operation of the distribution network. This drive for decarbonisation will result in further significant growth in technologies that will place ever increasing electrical demands on the network. The factors outlined below present the challenge of how the existing distribution network can accommodate these demands in the most cost-effective way while maintaining the current safety, availability, security and quality standards. It is evident that major changes in how the industry manages and operates the network are required. NIE Networks' role is to assess this changing environment and to ensure the electricity network is developed to enable and facilitate this transition in a timely manner ahead of need.

6.1.1 Renewable Generation Continues to Grow

In 2010, The Department of Enterprise, Trade and Industry *(DETI)* issued an ambitious target for Northern Ireland, that by 2020, 40% of the electricity consumed in the region would be from renewable resources[113]. NIE Networks played a key role in facilitating this change and by the summer of 2019 the target had been exceeded, with 44.9% of electricity consumption in Northern Ireland generated from renewable sources located in Northern Ireland, a figure which has risen to 49.2% by December 2020, as illustrated in Figure 3, with 84.9% of the total renewable electricity generated being from wind.

This is the result of the decentralisation of generation, with 2027MW of renewables committed or connected in Northern Ireland, highlighted in Figure 4, and over 90% of this connected to the distribution network.

According to the DfE, power has been the major success story in reducing carbon emissions in Northern Ireland, with energy supply *(mainly electricity generation)* emissions falling by 59% from 2000 to 2017. GHG emissions per unit of electricity generated decreased by 36% between 2004 and 2017[114].

The emergence of distributed generation at the customer premises has led to the evolution from a 'passive' distribution system to an 'active' one, with bidirectional power flows throughout the network. Consequently, the management of network power flows has become increasingly complex. The majority of the wind generation is located towards the west of the region, attributed mainly to the higher wind speeds in that region, which creates difficulties in transporting power to the east where the majority of demand is located. One way in which NIE Networks has optimised the connection of renewable generation to the

distribution network, whilst respecting Northern Ireland's landscape and cultural heritage, is to group generators so that they share network infrastructure through their connection to a centrally located 'cluster' substation in that vicinity.

When the level of connected renewable generation is viewed in the context that Northern Ireland experiences a summer minimum electrical demand of approximately 0.5GW and a winter maximum of around 1.8GW, it is easy to appreciate the challenge of such a proliferation of connected renewables. In practice, this means that during times of minimum electrical demand in the summer, the capacity of connected *(or committed to connect*) renewable generation can be up to 400% that of the electrical demand on the system. With the levels of renewable generation connecting to the distribution network expected to increase to meet a new renewable generation target by 2030 *(expected to be set at a minimum of 70%*[115]*)*, NIE Networks needs to evolve its traditional DNO role in order to continue to effectively facilitate the low-carbon future.

6.1.2 Electric Vehicle and Heat Pump Uptake Is Accelerating

As observed in Chapter 4, the electrification of heat and transport will increase the demands on the distribution network. Furthermore, these LCTs are unlikely to have the same diversity that conventional electrical demands have. For example, EV owners may come home from work and plug in their EV around the same time, and it is apparent that heat pumps consume maximum power as the outside temperature drops. A clustering effect is also likely to be prevalent with LCTs, for example, affluent developments are more likely to have high deployments of EVs.

LCTs are extremely demand intensive and have low location and time of use diversity levels, meaning they have the ability to erode the diversity which has been relied upon by network planners and to create large system peaks. The challenge for NIE Networks is managing the resulting constraints in the most effective way. This will require new innovative methods to continue the safe and secure operation of the network while minimising the cost of the associated network reinforcement.

6.1.3 Customer Choice and Behaviour

Many customers can no longer be considered as passive consumers of electricity. Numerous customers have become active through the development and popularity of technologies which allow users to generate their own electricity and to actively manage their own consumption patterns. PV panels are now common place on the rooftops of domestic properties with nearly 18,000 domestic PV installations[116] allowing customers to provide their own generation during daylight hours whilst simultaneously supressing system demand. Energy storage technology is rapidly improving and its use is beginning to grow at industrial premises as well as in household storage schemes for energy trading. Businesses and households have now the ability to make considerable savings through actively managing their use of electricity. Energy storage also facilitates increased PV self-consumption and supply back-up.

It is evident that the electrical appliances connected within typical homes and businesses are becoming increasingly 'smart', offering opportunities to their users which previously were not attainable. It is important that the network is able to assist these smart technologies in providing benefits to both customer and network operator alike.

6.2 DSO TRANSITION

To effectively manage this changing landscape, it is acknowledged that DNOs will need to evolve their roles and responsibilities, a change which is often referred to as the evolution from a DNO to a DSO.

This is the future direction of travel for operating a distribution network, and one that NIE Networks is embracing. This shift will create a host of new opportunities, both for the more intelligent management of the network and for the network to act as a platform for the greater deployment of smart energy technologies, with all the benefits that this will bring for customers.

NIE Networks is not alone on this journey and the ENA, who represent the 'wires and pipes' transmission and distribution network operators for gas and electricity in the UK and Ireland, has considered what this evolution will entail through the Open Networks Project. This project[117] has developed a working definition of a DSO:

> "A Distribution System Operator (DSO) securely operates and develops an active distribution system comprising networks, demand, generation and other flexible distributed energy resources (DERs). As a neutral facilitator of an open and accessible market it will enable competitive access to markets and the optimal use of DERs on distribution networks to deliver security, sustainability and affordability in the support of whole system optimisation. A DSO enables customers to be both producers and consumers; enabling customer access, customer choice and great customer service."

The transition to a DSO does not mean forsaking the traditional roles of a DNO. Instead, it represents the introduction of new and innovative functions which will lead to the furtherance of NIE Networks ability to maintain and operate the distribution system in the best possible way for all customers. The transition will not only benefit active customers through the facilitation of access to markets, but will also benefit all customers through minimising future network costs in the delivery of a low carbon economy. NIE Networks has defined the role of a DSO into seven key areas.

Figure 34 - The Functions of a DSO

6.2.1 Market Facilitator

With the emergence of high levels of distributed renewable generation has come the introduction by the TSO of the DS3 *(Delivering a Secure Sustainable Electricity System)* System Services market, which incentivises DERs to actively change their electrical behaviour for system wide benefits. However, the participation in this market by DERs which are connected to the distribution network can impact the integrity of the distribution system.

NIE Networks has previously provided 'operational windows' to allow participation in this market, but these are static and can prove to be restrictive. In order to facilitate increased access to the distribution system for customers, it is proposed to introduce a new network capacity allocation platform, which will provide dynamic information on real time power flows and network topology to assign capacity accordingly. This will allow greater customer participation in this market and consequently provides whole system benefits. In addition, an innovative 'Nodal Controller' is being trialled which can co-ordinate additional services from downstream distributed generation in order to reduce network electrical losses and improve system stability, whilst ensuring no distribution limits are breached.

It is envisaged that local markets will also be established, allowing network congestion to be relieved whilst presenting greater opportunities for customers to further actively participate with the distribution system. Throughout this process, NIE Networks will perform a key role as a neutral market facilitator of these open and accessible markets.

6.2.2 Service Provider

NIE Networks already provides services to the TSO, but these are under infrequent system critical circumstances and include high impact actions such as load shedding in order to safeguard the security of the wider system.

Within the distribution network, there is the potential to flex existing network assets to provide further services to the TSO and to offer other system wide benefits. These services could be utilised by the TSO on a more frequent basis, with little to no impact on connected customers, to help maintain system stability. This represents an extension of the existing process, and if developed and managed correctly by the DSO these services can be delivered without compromising the security or quality of supply for customers.

6.2.3 Congestion Management

NIE Networks is responsible for investment planning on the distribution system to ensure that future demand and generation growth can be accommodated without compromising the safety, quality and security of supply. Since local demand is projected to increase significantly due to the electrification of heat and transport, it is vital that the appropriate processes are in place for managing any resulting network impacts.

There are two investment philosophies that can be adopted:

- a conventional reinforcement strategy deploys traditional solutions such as building new infrastructure including lines, cables and substations, installing larger transformers and increasing the cross-sectional area and thus capacity of overhead lines and cables; or
- a smart incremental strategy continues to deploy traditional solutions as above but, where appropriate, minimising these investments through deployment of smart *(network flexibility)* and market-based *(customer flexibility)* solutions.

As part of this smart incremental strategy, NIE Networks is currently trialling six innovation projects in Northern Ireland. These are:

1. LV ANM - The Low Voltage Active Network Management project will investigate how reconfiguring the network will provide additional capacity for LCTs;
2. DRVC - By dynamically reducing network voltage, electrical demand can be reduced locally. The Demand Reduction through Voltage Conservation project will seek to manage network constraints;
3. FESS - The Facilitation of Energy Storage Services will seek to identify and remove any barriers that exist to customers deploying energy storage devices such as batteries;
4. FLEX - This Demand Side Response *(DSR)* project will establish a DSO flexibility market;
5. SAM - Using real time thermal rating technology for plant and equipment, instead of a static nameplate rating approach, the Smart Asset Monitoring project will seek to increase network headroom; and
6. STATCOM - This project will actively manage network voltage through the installation of a static compensator on an 11kV circuit. This will accommodate further demand and micro-generation which would otherwise be constrained by voltage levels.

If successful these projects will provide lower cost alternatives to conventional network reinforcement moving forward, using both smart and customer-based solutions to defer costly conventional network investment. With regards to FLEX, listed above, further detail on this project is outlined below and in Appendix 11.3.

CASE STUDY – FLEX BY NIE NETWORKS

Flexibility is described as a customer's ability to adjust their electricity consumption or generation in return for financial reward. Using Flexibility marks a significant milestone on NIE Networks' journey towards becoming a Distribution System Operator through enabling the management of demand and generation on the network to maintain and enhance security of supply for customers.

NIE Networks has launched its first ever Flexibility tender as part of the FLEX innovation project discussed above. Seventeen Flexibility Trial Zones have been identified, distributed across Northern Ireland, covering 15% of all customers. This tender offers customers opportunities to support their local distribution networks by being flexible with their electricity consumption or generation, earning revenues in return.

The aim of the project is to evaluate the technical and commercial viability of utilising customers' Flexibility to overcome network constraints and defer reinforcement, minimising costs for both NIE Networks and the wider customer base. If the trial is successful, Flexibility could be used to manage emerging network congestion in future regulatory periods.

The trial zone locations, along with the key details, have been published online via the Piclo Flex platform www.picloflex.com

(For more information see Appendix paragraph 11.3)

NIE Networks is also engaged in other flexibility trials, a further example of this is the Girona project, outlined in the case study below.

CASE STUDY – GIRONA BY NIE NETWORKS

NIE Networks has been supporting Project Girona, with the Electric Storage Company, and is a smart-grid research and development project exploring the impact of small-scale electrical energy storage on the distribution network in Northern Ireland. The project offers businesses and domestic customers on the North Coast the opportunity to access clean energy, and aims to provide a more flexible approach for customers resulting in estimated savings of around 40% on domestic electricity bills.

Project Girona aims to reduce energy waste by providing generating customers with the ability to store renewable energy, through the installation of a battery storage system, for use whenever it is needed. For example, the maximum generation output of a solar panel is at midday, when household energy usage is at its lowest. The battery will allow the storage of this solar energy for use later in the day when household energy consumption peaks, increasing the usefulness of energy generated. When all the energy in the battery has been used, the system automatically reverts back to mains supply, ensuring customers are never are without electricity.

The project is also exploring how energy flexibility as a service can be implemented by aggregating a number of battery storage systems to provide services in various markets including capacity, system services and network flexibility, helping to support the electricity system.

Project Girona sets out to bring cheaper, cleaner, smarter and more flexible energy to domestic customers, providing an easy, inexpensive way to incorporate smart solutions like solar panels, battery storage and decarbonisation of heat and transport in their daily lives. The project will conclude in February 2022, during which time the team will continually test, collect and analyse data from across the project area to enable a business case for change and start the energy revolution.

(For further information visit gironaenergy.com/)

6.2.4 Connections

With approximately 2GW of generation connected or committed to connect to the NIE Networks' transmission and distribution networks *(Figure 4)*, there is limited unused capacity for future generation to connect in the absence of additional network capacity being created.

NIE Networks has updated its generation connection policies, taking effect from 2020. These changes will help to remove barriers to domestic energy storage, facilitate further connections of micro-generation and will significantly reduce the connection times of such schemes. The issue of connections charging was previously outlined in Chapter 3.

It is also NIE Networks' desire to provide customers with options on how they connect to the network and to utilise innovation to connect customers in what is a heavily congested network. Flexible connections is one such approach, where a generator is permitted to connect when otherwise no connection would be available, on the basis that the generator's export to the grid is not unrestricted but managed according to the real time capacity of the network.

6.2.5 Data Provision

As the volume of DERs connecting to the distribution network increases, so does the need to have greater data and visibility of the network. This is necessary to ensure the efficient development and operation of both the distribution and transmission system.

Triggered by the high and increasing levels of decentralised generation, it is proposed to develop near time forecasting for the distribution system which could be communicated to the TSO in order to enable greater whole system forecasting. Whilst there is already visibility of the higher voltage networks, it is acknowledged that greater visibility is required for the lower voltage network where system congestion and the deployment of innovative solutions will increase. It is planned to upgrade IT systems and install additional monitoring equipment to provide this capability. In 2019, a publicly available capacity map for both demand and generation was developed to improve customer investment decisions[118].

Greater customer metering functionality would provide an abundance of useful data for system operation. It would also provide greater opportunities for customers in how they can actively manage their own consumption of electricity. NIE Networks will continue to work with the DfE to supply the potential network benefits associated with greater customer metering functionality, allowing these to be considered in the DfE's Cost Benefit Analysis review of Smart Metering.

NIE Networks will ensure that this approach of increased data openness, accessibility and visibility will be conducted whilst respecting cyber security and data protection obligations.

6.2.6 Network Management

In order to appropriately manage the day-to-day operation of the distribution system with high levels of DERs connected to it, there are several key network management changes that are required.

When an outage is required to carry out planned or customer work on the network, the process traditionally adopted was to determine if an outage and any associated network reconfiguration could proceed based on historical power flows. However, there is currently limited data available on the DER output. By taking account of generation and demand forecasts, outages can be planned in a more informed way.

When planning an outage, generation is sometimes required to be constrained *(reduced or disconnected)* as the system would be operating abnormally for this period of time. In general, generation is only connected and charged for a Normal System Operation connection and therefore may have to be constrained under Abnormal System Operation arrangements. Generally conservative assumptions are applied when determining the level of constraint. Upgrades to the existing Network Management System will allow the level of generator constraints to be minimised, increasing renewable energy utilisation and driving down costs for the general customer base.

QUEEN'S UNIVERSITY BELFAST

CASE STUDY – CONGESTION MANAGEMENT BY QUB EEECS

The increased adoption of low carbon technologies *(LCT)* has the potential to deliver financial benefit and efficiencies to owners but also present challenges around system operation to ensure the continued safe, secure and reliable power system in the future.

The QUB School of Electrical and Electronic Engineering and Computer Science study in collaboration with NIE Networks has investigated how battery storage devices can be incorporated into distribution networks to relieve constraints which may be caused by the widespread uptake of LCTs and renewable generation.

The study was performed using information from two real 11kV distribution networks in Northern Ireland and demonstrated how battery storage can facilitate the increased adoption of LCTs and renewables while ensuring that the network continues to operate safely and securely.

The study also showed how storage devices can be used for providing ancillary services in the network, subsequently helping to improve quality of supply to end users and enhancing network security and stability. The study showed that by incorporating battery storage devices, the utilisation of current distribution network assets can be maximised, which will have considerable benefits, largely economic, compared to conventional network reinforcement.

(See Appendix paragraph 11.4 for more information.)

6.2.7 Charging

How and when customers want to use electricity is changing. Set against this, the emergence of smart technologies and innovative business models offer opportunities to adjust demand and supply at times and places where there are network constraints.

As a consequence, some customers will be using less electricity from the network while still having a connection for security of supply. It is intuitive that reduced usage from some customers *(active customers)* will reduce the consumption across the customer base. The networks costs are then recovered over a reduced consumption which could increase network unit charges for all customer types unless pricing arrangements are reformed. Rebalancing network costs will provide a fairer and more appropriate allocation of costs. In order to protect passive customers who do not have technologies to manage their demand, including customers in vulnerable situations, NIE Networks would adjust its system charges to recover less through volumetric charges and more through fixed charges based on paying for a certain capacity.

NIE Networks would advocate for different price structures and tariffs, along with increased time of use pricing to be introduced to recognise common modes of behaviour, such as PV users, or user flexibility such as customers who participate in Demand Side Response. This will allow these customers to get the most out of their connection to the distribution system. Greater metering functionality is required to facilitate some of these functionalities to maximise customer benefit. Such changes in metering functionality will require consultation with electricity suppliers as well as involvement of the DfE and the Utility Regulator in respect of wider metering strategy and price control impacts.

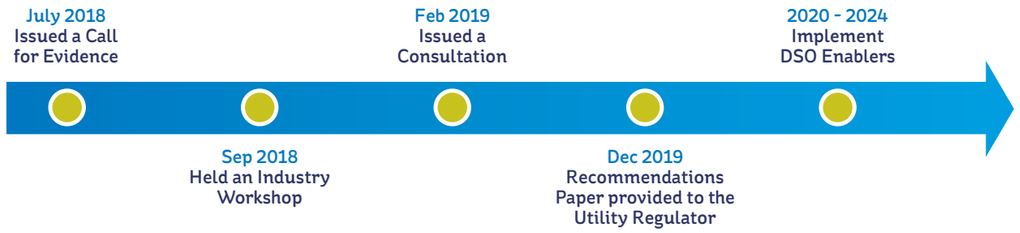


Figure 35 - Timeline for DSO Enablers

6.2.8 Timeline

It is NIE Networks' intention to develop the seven DSO functions, outlined above, on its evolution from DNO to DSO prior to the next regulatory price control in 2024, subject to Utility Regulator approval of the necessary funding. This will help establish a network which is sufficiently developed and flexible enough to be able to meet the demands of a decarbonising economy and will aid the timely implementation of solutions to facilitate achieving future decarbonisation targets set for Northern Ireland. The functions described will be implemented in parallel in order to deliver tangible benefits before 2024 for all stakeholders and to obtain operational learning to inform the next regulatory price control framework.

6.2.9 Future Pathway

NIE Networks has commenced the DSO transition by beginning to implement the enablers previously described. However, these enablers are simply a foundation upon which to build and their successful implementation will not represent the conclusion of the DSO transition. Rather this transition will require continuous evolution of roles and further development of network capabilities, resulting in a progressive pathway over the coming years. This concept is illustrated in Figure 36 below, which outlines NIE Networks' vision of DSO progression to facilitate drivers such as renewable generation penetration *(likely to increase towards 100% by 2050)* and the levels of electrification of heat and transport *(potential scenario for up to 690,000 heat pumps and 1.2 million electric vehicles by 2050[119]).*

The developing roles and capabilities expected over the coming years can be categorised into five transition enablers, which are listed and explained in Table 8 below along with detail of how NIE Networks envisages these categories need to evolve in practice. The examples can largely be considered as natural extensions of the enablers and innovative projects which are currently being progressed. As plans continue to be developed to meet the targets and network requirements of the future, NIE Networks will continue to engage with stakeholders and be guided by industry best practice including through the ENA Open Networks project.

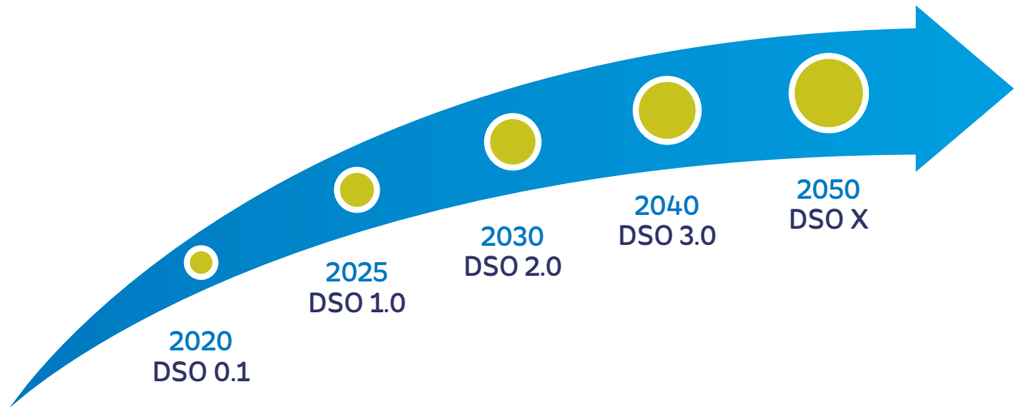


Figure 36 - Future DSO Pathways

Enabler	Description	Related DSO Function	2030 Pathway	2050 Vision
Network Visibility	Facilitation of increased renewable targets, flexible market arrangements and targeted investment in the network requires detailed knowledge of electrical demand and generation activity at the point of connection. Evolution of NIE Networks' DSO role requires visibility down to the Low Voltage *(LV)* networks through additional monitoring at substations and customers premises.	Congestion Management Data Provision Network Management	Full high-resolution visibility of the entire High Voltage *(HV)* network Real-time LV network visibility at all sites with high LCT uptake Greater metering functionality at vast majority of customer premises.	Full real-time visibility of all network assets
Network Controllability	Alongside enhanced visibility of the network, enhanced control of the network is imperative to facilitate access to 3rd party and DSO markets, optimise utilisation of the network in the most efficient manner and minimise costs to customers.	Data Provision Network Management Congestion Management	Increased network automation across all voltage levels Smart solutions widely utilised in conjunction with conventional reinforcement	Fully controllable smart network with flexible loads and generation, and autonomous system optimisation
Customer and Commercial	It is incumbent on the DSO to ensure customers have access to open data across different time horizons on which to make informed customer choices. Information about network capacity, energy management and access to dynamic tariffs will ensure customers have control over their energy future.	Connections Market Facilitator Data Provision Pricing	Flexible generation and demand connections established Flexible/dynamic tariffs Fully interactive Capacity Map across all voltage levels	Unbundled customer tariffs with local/real time tariff signals established.
Market Operability	Customers will evolve during this energy transition to become more active in managing their energy needs. As DSO, NIE Networks must ensure customer desires are met by providing them access to a range of emerging markets, including DSO markets.	Market Facilitator Service Provider Congestion Management	Dynamic instruction sets introduced to facilitate enhanced market access Network Markets (e.g. FLEX) widespread DSO participation in System Services Customer Capacity Trading	Widespread 'Peer to Peer' trading. Agile evolution in response to market changes
Systems and Data	Development of internal IT, communications infrastructure and systems for data storage, analytics, provision and security are pre-requisite for both customers and the DSO.	Data Provision	Enhanced Network Management Systems to enable visibility and control functions Full mobile operational capability to enhance customer responsiveness Single source data to facilitate ease of access and sharing of data with stakeholders	All Systems & Data Management processes fully integrated to support DSO functionality

Table 8 – DSO Transition Enablers

6.3 CUSTOMER BENEFITS

It is clear that the transition to a DSO will deliver whole system benefits. However, it is the intention of NIE Networks that customers are at the centre of this DSO evolution, and ultimately the success of the transition will be measured according to what benefits it can bring for customers.

To reflect this principle NIE Networks has engaged with stakeholders throughout this journey in order to shape a transition which will deliver benefits for all customer groups, by means of downward pressure on system charges and the removal of barriers to empower users to take advantage of new opportunities. Benefits to the customer include:

- The DSO transition will benefit active customers through the facilitation of access to markets, but will also benefit all customers through minimising future network costs in the delivery of a zero-carbon economy.
- The transition will help improve the environment and air quality by developing systems that support the growth of renewables and the switch to electric vehicles and heat pumps, facilitating the decarbonisation of the energy sector.
- Active customers can extract maximum value from their assets through accessing a range of markets. It is envisioned that by transitioning to a DSO, NIE Networks will also facilitate additional organisations acting in various markets, enhancing competition and minimising the cost implications of these markets for the benefit of all customers.
- Provision of services to the TSO from the distribution network will have the benefit of increasing whole system security, and utilising existing assets to provide these services is likely to represent the least cost solution for the customer.
- Utilising smart technologies and market-based solutions to facilitate the connection of LCTs will defer costly conventional reinforcement by maximising the utilisation of the existing electrical and communication networks.
- Streamlining the connection process for micro-generation and storage will make it easier for further renewable generation to connect. Flexible connections will enable the connection of further renewable generation customers at a lower cost and significantly earlier than traditional reinforcement would allow.
- In terms of data provision, providing enhanced forecasting data to the TSO is likely to reduce system balancing costs, again benefitting all customers. Greater visibility and accessibility of real-time data can also better inform investment decisions for both NIE Networks and stakeholders.
- Improving network management will reduce generation constraints, producing an overall financial benefit for the wider customer base.
- A full review of the network pricing structure will ensure that costs are recovered in a fair manner across all customer groups.

The DNO to DSO transition represents how NIE Networks is embracing the future to deliver for customers by undertaking the most significant change on the distribution network in decades. NIE Networks will continue to evolve in order to navigate this changing electricity landscape and to ensure that these benefits will be made available to customers.

Northern Ireland Electricity Networks

7. NETWORK COST IMPACT

CHAPTER 7 – NETWORK COST IMPACT

- **Network Incremental Costs** – Additional expenditure on the transmission network is largely dependent on the amount of renewable energy source installed whereas the uptake of LCTs primarily impacts on the distribution network. The estimated costs relate to the 2030 targets associated with the central scenario from Chapter 4 (Achieving Climate Change) and Element Energy World B from Table 2;

  – distribution network incremental costs are forecast to be £140m; and

  – transmission network incremental costs are forecast to lie between £385 million and £560 million.

- **Impact of Investment on Price** – In assessing the impact on network costs per MWh, the expected increase in electricity demand and the investment costs over the period to 2030 have been considered.

- On average, network costs comprise 25% of domestic customer bills. Assuming no other changes in pricing structure, and taking this average bill composition, NIE Networks estimate that in 2030, the charge to domestic customers relating to network costs would result in a 1% reduction in the overall cost they pay per unit of electricity consumed.

- The recovery of network costs per MWh will decrease in spite of the fact that total spend on electricity consumption will increase as we move away from carbon-based fuels.

NIE Networks and SONI have estimated the incremental costs to the distribution and transmission networks for the range of LCT uptakes associated with the 3 modelled TESNI scenarios as per Table 2. The renewables target has a significant impact on transmission network reinforcements to ensure transfer of power from sources of generation to demand in Northern Ireland whereas the uptake of LCTs has a larger impact on distribution network reinforcement requirements. As such, the estimated costs discussed below relate to the 2030 targets and represent a ten-year timeframe.

7.1 DISTRIBUTION COSTS

NIE Networks has assessed distribution costs using the EA Technology Transform Model[120] which was used to calculate network allowances for LCT impacts for the current price control period RP6. EA Technology Limited developed this industry accepted parametric model, to forecast the impact that LCTs will have on distribution networks in terms of capacity and investment needs and was originally developed to support the GB DNOs in their last price control RIIO-ED1 submissions[121].

The costs listed in Table 9 are the cumulative marginal costs out to 2030 associated with distribution network reinforcement due to LCT uptake i.e. EVs, PVs, storage and heat pumps. For the purposes of this study, they are reflective of conventional reinforcement requirements across the distribution network.

RES	Element Energy World	Estimated Incremental Cost
60%	A	£112 million
70%	B	Central Cost £140 million
80%	D	£206 million

Table 9 - Summary of Distribution Costs to 2030

These incremental costs are additional to traditional Business as Usual expenditure and due specifically to the impacts of LCTs. They do not include the following:

- Business as Usual Load related – normal incremental load / fault level related expenditure related to normal economic activity which is assessed separately;
- Business as Usual Distribution Asset replacement;
- IT, data and communications;
- Smart solutions – for the purposes of this assessment conventional reinforcement has been assumed;
- NIE Networks is assessing smart solutions as part of RP6 trials and any benefit from adoption will need to be assessed in the future;
- Any DSO or associated network enabling costs;
- Network reinforcement costs associated with connections of renewables which are not charged directly to connectees.

7.2 TRANSMISSION COSTS

Total Transmission costs relate to the draft Transmission Development Plan for Northern Ireland *(TDPNI)* 2020-2029[122] and as assessed with the TSO in the Joint Working Group. They include provision for transmission system reinforcement as well as asset replacement projects[123] estimated to cost approximately £759 million over ten years for the 70% RES scenario. This plan also accommodates asset replacement, continued operation of existing renewables and mitigation of existing constraints, and is considered sufficient to meet a high 2030 renewables target. Table 10 summarises the transmission estimated costs out to 2030 for each RES target.

RES	Element Energy World	Estimated Cost	Projects
60%	A	£584million	Additional 110kV reinforcements. Excludes 275kV western reinforcement
70%	B (with offshore wind)	Central Cost £584 million[124]	Projects as per RES – 60% Scenario Excludes, 275kV western reinforcement
	B (without offshore wind)	£584 million + cost range £175 million to £350 million	Includes, 275kV western reinforcement
80%	D	£584 million	Includes, 275kV western reinforcement

Table 10 - Summary of Transmission Estimated Costs Out To 2030 based on TDP NI 2020-2029

7.3 IMPACT OF INVESTMENT ON PRICE

Given the scale of investment required to prepare the existing Northern Ireland electricity infrastructure for a Net Zero future, NIE Networks has undertaken some high-level modelling to evaluate the impact of this investment on the cost of electricity. It should be noted this analysis is purely indicative and based on high level assumptions.

To do this, NIE Networks has assumed the costs associated with the 70% RES scenarios from Table 9 for Distribution costs and the central 70% RES scenario from Table 10 for transmission costs. Distribution incremental direct costs are assessed at £140m between 2021 and 2030 in 19/20 prices and the required Transmission costs at £750m *(£584m + £175m) between 2021 and 2030 in 19/20 prices)*. The historic average annual investment in Transmission related spend has been deducted to provide an assessed incremental investment required to achieve a 70% renewables target.

These assumed costs have been modelled through NIE Networks' regulatory revenue model to calculate the amount that NIE Networks would seek to recover via DUoS and Transmission System Charges *(TSC)* across the 2021 - 2030 period. This takes account of NIE Networks' current level of return on capital investment together with any reduction in tax allowances NIE Networks will experience due to capital investment based on the current RP6 price control framework. The impact of inflation changes has not been included in this assessment. All other spend is assumed to remain equal.

In the event that there was no increase in electricity demand, the calculations show that NIE Networks' regulatory revenue would increase by 6% above 2020 level by 2025 and 14% above 2020 level by 2030.

However, given the expected increased usage of electricity arising from the electrification of heat and transport, the increase in user demand also needs to be considered. To this end NIE Networks considered the increased demand assessed by SONI in the Achieving Climate Change scenario outlined in the TSOs TESNI report[125]. This scenario aligns to the cost assumptions outlined above.

The demand forecasts in SONI's TESNI Report represent a 12% increase in electricity demand by 2025 and a 19% increase in demand by 2030 when compared to the demand assumed in NIE Networks' 2019-20 tariff which excludes the impact of COVID 19.

If NIE Networks were to charge DUoS & TSC evenly across each MWh of electricity consumed, the cost of each MWh of electricity consumed would decrease by 2025 and 2030. This is illustrated in Figures 37 and 38.

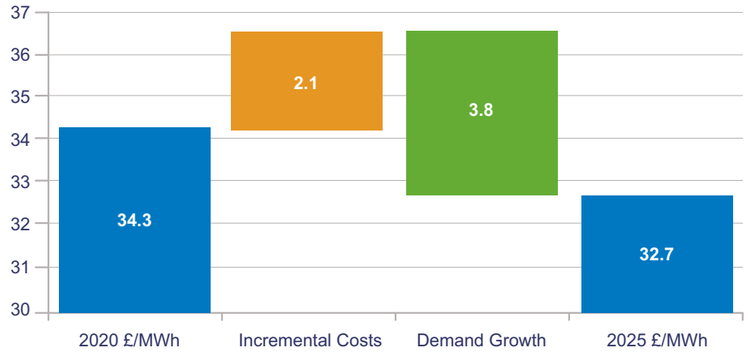


Figure 37 - The Cost of Each MWh of Electricity Consumed Would Decrease By 2025

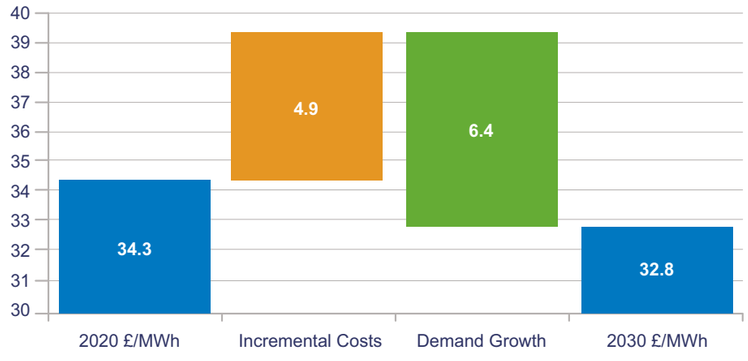


Figure 38 - The Cost of Each MWh of Electricity Consumed Would Decrease By 2030

The net impact is that the recovery of network costs per MWh will decrease in spite of the fact that total spend on electricity consumption will increase *(with consumers spending less on fossil fuels).*

The allocation of DUoS & TSC charges across the range of electricity tariffs is complex and therefore not as straightforward as spreading charges evenly across all electricity consumed. However, on average, network costs comprise 25% of domestic customer bills. Assuming no other changes in pricing structure, and taking this average bill composition, NIE Networks estimate that by 2025 and 2030, the charge to domestic customers relating to network costs will result in a 1% reduction in the overall cost they pay per unit of electricity consumed.

Northern Ireland Electricity Networks

8. SUSTAINABILITY AND NIE NETWORKS

CHAPTER 8 – SUSTAINABILITY AND NIE NETWORKS

- **Sustainability** – In the development of its Sustainability Action Plan, NIE Networks has considered both the UN's Sustainable Development Goals and the EDSO Sustainable Grid Charter to which it is a signatory. NIE Networks has developed four key areas of focus for sustainability. These include:
  - Community: Our corporate social responsibility to protect the safety of our communities and outreach within them;
  - Environment: Working to decarbonise the network and enabling the uptake and use of clean energy resources;
  - Workforce: Providing equal opportunities, a safe working environment, training and a culture of zero harm; and
  - Future Proofing: Commitment to innovation through our Future Networks Department and continued management of assets.
- **Our Sustainability Action Plan 2021-2024** – This plan focuses on four key areas: Climate Action, Supply Chain and Contracts Reform, Health and Wellbeing, and Diversity and Inclusion. In order to maintain focus on Net Zero issues, only Climate Action has been discussed in this document. Information on Supply Chain and Contracts Reform, Health and Wellbeing, and Diversity and Inclusion is provided in a separate publication.
- **Climate Action** – Our Climate Action addresses Business and Network Carbon footprints.
- Our Business carbon footprint is impacted primarily by operational fleet transport *(c60%)* and building energy usage *(c25%)*. NIE Networks has committed to reducing its business carbon footprint by 12.5% by 2024 from a 2019 baseline.
- Our Network carbon footprint is impacted primarily by network losses. Network losses are an inevitable electrical phenomenon occurring when power is transported. The challenge will be to continue with the successful decarbonisation in this sector which will also have the desired effect on carbon reduction associated with losses. In addition, we are exploring alternatives to other contributors such as Sulfur hexafluoride (SF_6) gas used for insulation in electrical equipment and oil in fluid filled cables

8.1 WHAT IS SUSTAINABILITY?

Sustainability focusses on meeting the needs of the present without compromising the ability of future generations to meet their needs. In assessing what this means for NIE Networks, we have considered work that has been undertaken by both the United Nations *(UN)* and E.DSO.

8.1.1 UN Sustainable Development Goals

The Sustainable Development Goals[126] *(SDGs)* set out by the UN in 2015 are considered the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face and as such are intentionally high-level.

NIE Networks has identified the following twelve SDG goals as being specifically relevant to our business, displayed in Figure 39 below. Of those identified, Affordable and Clean Energy, Industry, Innovation and Infrastructure, and Climate Action are most relevant to the achievement of Net Zero targets.

Figure 39 - UN Sustainable Development Goals

8.1.2 E.DSO Sustainable Grid Charter Compliance

The Sustainable Grid Charter, as developed by E.DSO, aims to distil goals like the UN SDGs down into industry-specific commitments.

While it does not involve legally binding commitments, NIE Networks, as a member of E.DSO and the new European Entity EUDSO, has endorsed and adopted this Charter to provide direction and momentum to our internal sustainability efforts[127].

8.1.3 The Four Key Pillars

After consideration of both the UN goals and E.DSO commitments, we have developed four key areas of focus for Sustainability at NIE Networks.

The 'Four Key Pillars' include:

1. Community: Our corporate social responsibility to protect the safety of our communities and outreach within them;
2. Environment: Working to decarbonise the network and enabling the uptake and use of clean energy resources;
3. Workforce: Providing equal opportunities, a safe working environment, training and a culture of zero harm; and
4. Future Proofing: Commitment to innovation through our Future Networks Department and continued management of assets.

Figure 40 - The Four Pillars

8.2 OUR SUSTAINABILITY ACTION PLAN 2021-2024

An exercise was undertaken to map the key NIE Networks business activities that demonstrate compliance against the UN Sustainable Development Goals, the E.DSO Sustainable Grid Charter and the Four Pillars of Sustainability at NIE Networks. A company-wide staff survey was launched to assess our current performance against each of these areas. The output from this exercise helped bring focus to particular areas of improvement and informed the development of the NIE Networks Sustainability Action Plan for 2021 – 2024. The Action Plan features four key areas: Climate Action, Supply Chain and Contracts Reform, Health and Wellbeing, and Diversity and Inclusion. In order to maintain focus on Net Zero issues, the Climate Action categories of Business and Network Carbon Footprints are presented within this Chapter.

As a DNO, we have a responsibility to support the UK target for Net Zero emissions by 2050 and it is equally important that we address our own business carbon footprint in line with SDG 13 (climate action). The Carbon Footprint of NIE Networks can be assessed in two main areas, the 'Business Carbon Footprint' *(BCF)* which comprises the energy consumed to sustain the organisation's premises and staff, and the 'Network Carbon Footprint' *(NCF)*. Our Energy Savings Opportunity Scheme *(ESOS)* analysis[128] highlighted that the NCF in terms of network losses accounts for 97% of our total energy consumption, whilst BCF accounts for 3%.

8.2.1 NIE Networks Business Carbon Footprint *(BCF)*

As illustrated in Figure 41 below, Operational Transport and Buildings Energy Usage are the predominant contributors to our BCF, representing 59% and 24% respectively. The remaining 17% is comprised of business travel, including both air miles and local business travel, and fuel combustion such as LPG[129], generator fuel and petrol.

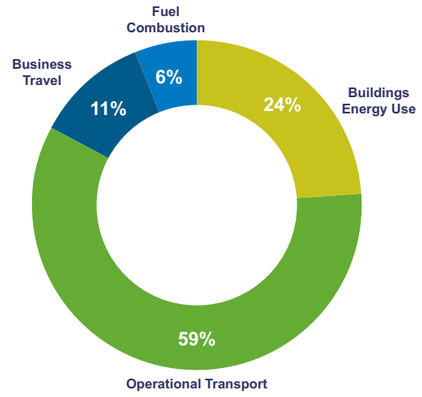


Figure 41 - NIE Networks BCF Breakdown for 2020

In line with our sustainability objective, we are committed to reducing the carbon impact of our operations and of our business energy consumption. Our Sustainability Action Plan for 2021-24 aims to deliver a 12.5% reduction in BCF against the 2019 baseline by 2024, using a phased approach as per Figure 42 opposite.

Throughout 2020, our reported business-related emissions decreased by 11% against a target of 5% reduction on our 2019 baseline. This can be mainly attributed to the temporary stand-down of some of our operational activities due to the Covid-19 pandemic. It is expected that as restrictions ease throughout 2021, our BCF will revert back to pre Covid-19 levels. We are therefore taking the necessary actions discussed below to limit this return and ensure a continual reduction on our 2019 baseline level.

Fleet Emissions

59% of our 2020 BCF can be attributed to our operational transport. To combat this, we have established an 'EV and EV Chargers' working group, which focuses on enabling the transition of our fleet to electric vehicles. Over the next four years, all small vehicles which travel within the mileage range of the proposed electric vans

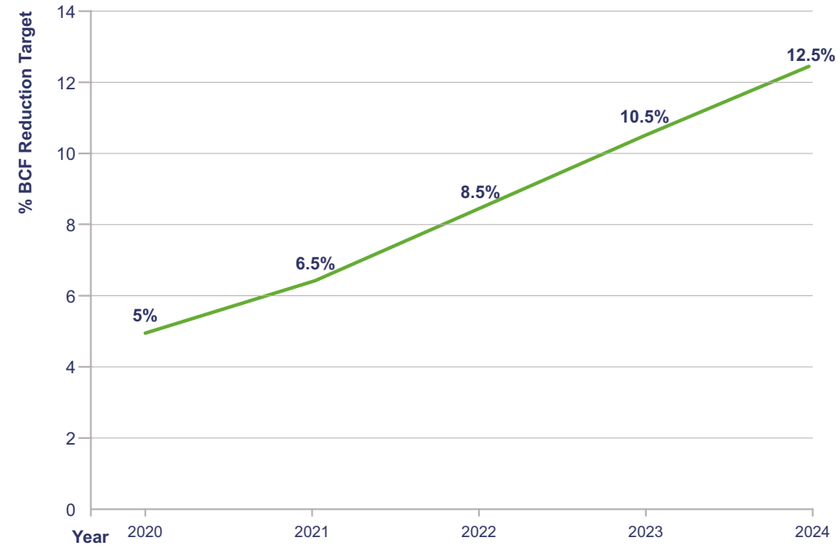


Figure 42 - Business Carbon Footprint Reduction Targets

will be transitioned to electric, equating to 40-48 vans *(c. 31% of small fleet)*[130]. This initial four-year plan will contribute to a net BCF reduction of 8% on our 2019 baseline, and will pave the way for future transitions as the range of EVs increases. We will begin to transition the larger vans within our fleet to low carbon vehicles as suitable alternatives become available.

To support the uptake of EVs by both employees and fleet, we plan to begin the installation of electric vehicle chargers at our relevant depots during 2021, targeting twenty-six charging points by the end of 2024. As 90% of our fleet vehicles are brought home at night, we are also committed to installing chargers at employee homes so they can fully charge their EV overnight in preparation for the day ahead. In tandem to this, we plan to encourage the uptake of electric vehicles by our employees and are reviewing our private transport policies to provide the necessary incentives to do so.

In order to encourage sustainable driving and identify vehicles which are suitable for transition to an electric equivalent, we have introduced a new vehicle tracker system to our fleet vehicles. We aim to use the information from this system to encourage more sustainable driving, creating personal accountability for the contribution that our driving style contributes to our carbon impact.

After a long-term initiative to reduce fuel usage by our fleet vehicles to a practical level, we continue to strive to maintain this usage at the lowest possible level whilst meeting the operational needs of our business. Following a number of reviews into fleet efficiency we have seen our fleet fuel consumption reduce by over 9% across the last 5 years. During 2021, prior to the roll out of EVs, we will continue to explore carbon efficiencies by strategically optimising the 'route and commute' of each fleet vehicle, preventing where practical the crossing of vehicle paths and unnecessary mileage.

Business Travel

As our business travel contributes 11% to our BCF, it is important that we take the necessary steps to eliminate all unnecessary travel. Covid-19 allowed us to accelerate the roll out of technology throughout our business, supporting the use of 'virtual meeting rooms' online and reducing our 2020 inter office travel by 32% from 2019 levels. We are also taking steps to eliminate all unnecessary air travel by remotely joining webinars and meetings.

We are committed to ensuring the sustained use of IT within the business, aided by the introduction of video conferencing rooms within our offices and an Agile Home Working policy in 2021 where our staff may be able to work from home several days a week.

Energy Consumption at Our Buildings

NIE Networks operates an aged office building stock and there have been concerted efforts to reduce energy consumption over the last number of years. Throughout 2020, 24% of our BCF can

be attributed to the energy consumption of our buildings.

Following a number of energy performance improvement initiatives across our largest premises, there is an increased focus on:

- reducing building BCF further by the adoption of low energy lighting;
- the adoption of low carbon heating;
- a reduction in printing;
- an increase in home working; and
- increasing awareness of BCF issues.

Across our full office building portfolio, we have seen on average a 13% reduction in electricity over the last five years through initiatives such as LED lighting, passive infra-red *(PIR)* sensor lighting controls and increased insulation. Our new Distribution Service Centre site at Craigavon will operate as a nearly zero energy building and all newly built network substations will have LED lighting installed.

Renewable Generation

Since 2005, photo-voltaic *(PV)* solar panels have been installed at our Ballymena depot, and we have plans to install more renewable technologies at our locations during 2021 and beyond.

8.2.2 NIE Networks Network Carbon Footprint *(NCF)*

Whilst network losses are the most significant contributor to our NCF, they are also an inevitable electrical phenomenon occurring when power is transported through wires, cables and equipment comprising the network. The challenge for the power system is:

- to continue progression to decarbonise this sector by utilisation of increased renewables *(UN SDG 7 affordable and clean energy)* thereby also having a desired effect on carbon reduction associated with network losses; and
- to reduce maximum demand on the network with load shifting incentives such as flexible tariffs.

Network losses are subject to more detailed consideration with regards to how the network is required to be developed in the future. As such, our focus for reducing our NCF is on other areas where we have more direct influence, such as limiting our SF6 gas emissions, and preventing oil leakage from underground cables, both of which can have detrimental effects on the environment.

SF_6 Emissions

SF_6[131] gas is commonly used throughout the electricity industry as an insulating medium in switchgear. Whilst the gas has many favourable electrical properties, it is also a potent greenhouse gas with a high global warming potential. It is estimated that 1kg of SF_6 released into the atmosphere is equivalent to 22,800kgs of CO_2, therefore, every effort must be made to restrict the release of SF_6 into the atmosphere.

There are currently no viable alternatives to SF_6 in high voltage equipment; however, we continue to record an inventory of all SF_6 activities, including emissions caused by equipment leakage and SF_6 recovered for destruction or reclamation.

We recognise that our performance in this area is at a practical limit and we strive to seek SF_6 alternatives in the market place as they become available.

Fluid Filled Cables

Older designs of high voltage underground cables contain oil to provide insulation. Whilst these cables are very reliable, in the event of damage by third parties or a fault, this oil may leak out into the surrounding ground.

We are taking the necessary steps to prevent oil leaks from fluid filled cables and to minimise our environmental impact by clearing any contaminated ground as quickly as possible. The fluid levels of our cables are continuously monitored, with a loss of oil pressure as a result of a leak presenting an alarm to the Distribution Control Centre so swift action can be taken. Oil leaks can also be quickly located using advanced technology tracers and repaired more rapidly than traditional technologies. We have introduced synthetic fluid to replace traditional hydrocarbon oil, and have a policy of purging oil from cables / plant and filling cables with an inert compound once they come to the end of their life.

Throughout RP5 and RP6 we have invested in the refurbishment and replacement of certain fluid-filled cables, repairing leaks, replacing leaking joints and accessories. With the wider availability of modern equivalent cables, we have moved away from installing new cables of this type.

Refurbishment of Plant

At our workshop facility, we are able to refurbish recovered plant and equipment such as transformers and ring main units for reuse on the network. We also train staff on alternative recycling initiatives and the reuse of materials such as overhead line cross arms, padlocks and bolts.

We have increasingly invested in the use of condition monitoring for our plant and cables in order to extend asset life. For example, we continually monitor the oil quality in transformers and process the oil in-house for reuse on the network. We have also installed partial discharge detection equipment to scan for potential internal failures and other monitoring technologies have been adopted to aid our inspection and maintenance programme.

8.2.3 Other Sustainable Initiatives

Our Sustainability Action Plan also encompasses areas not directly linked to our carbon footprint, such as the reform of our Supply Chain and Contracts to incorporate sustainability requirements into equipment specifications and the reduction of single use plastics throughout our business. In addition to this, we focus on the Health and Wellbeing of our employees by providing regular events to promote mental and physical health. As an ISO 14001 accredited company, we have implemented several Environmental Initiatives ranging from biodiversity enhancement to our continued partnerships with charities such as Ulster Wildlife. We are also committed to promoting Equality, Diversity and Inclusion within our business, supported by the delivery of our Bronze Diversity Charter Mark Action Plan *(awarded for gender)* and STEM educational outreach.

Further details of our Sustainability Journey to date can be found within the 'NIE Networks Sustainability Roadmap' featured in Appendix 11.2.

8.3 OUR COMMITMENT

To conclude, NIE Networks is committed to ensuring our business has a minimal or positive impact on the local, national and global environment, community, society and economy. We will continue to support and facilitate the UK Net Zero targets, deliver our Sustainability Action Plan for 2021-24 to achieve a business carbon footprint reduction of 12.5% *(against our 2019 baseline)* and embed Sustainable practices within our everyday business operations.

Northern Ireland Electricity Networks

9. DELIVERING THE FUTURE

CHAPTER 9 – DELIVERING THE FUTURE

- **Supporting the Customer** – In delivering Net Zero, there is a need for greater engagement with communities and customers. Likewise, there is a requirement for the support of the most vulnerable in society. While people are generally prepared to make the changes needed they need help and advice on how to do so.
- Downward pressure on electricity costs for customers is required and options that minimise the impact of costs are considered.
- **Energy Efficiency First** – Significant consideration has been given to decarbonisation in other jurisdictions. The European direction advocates the following approach: *(a)* a more circular energy system with energy efficiency at its core, *(b)* a greater direct electrification of end user sectors, and *(c)* the use of renewable and low carbon fuels including hydrogen for end use applications where direct heating or electrification are not feasible.
- **Sense of Urgency** – Progress should be made immediately in areas which are capable of advancing e.g. development of future homes standards for Northern Ireland, funding mechanisms for building retrofits and encouraging electrification using current technologies where possible.
- **Commitment to Net Zero** – NIE Networks would support a Climate Change Bill for Northern Ireland to help meet the 6th Carbon Budget of 82% GHG reduction by 2050 and to pursue efforts to reach 100% Net Zero as soon as practicable thereafter as a fair contribution to the UK Net Zero target.
- **Power** – Grid capacity is now limited and must be provided at sufficient capacity ahead of need and to avoid having to upgrade again prior to 2050.
- The suitability of the planning process in Northern Ireland should be assessed in light of the network infrastructure projects that will be required to meet Net Zero targets. For example, the construction of the North / South Interconnector and wider infrastructure development is urgently required.
- NIE Networks considers that a smart metering programme is a key enabler and would support a review of the case for smart metering to ensure both customer and network benefits are assessed.
- **Heat** – Essentials for heating sector are a) modify Building Regulations to align with the 'Future Homes Standard' in the UK and b) a significant building retrofit programme is required.
- Continued use of oil and gas is not consistent with net zero and should not be used in new homes. Extension of the gas grid and repurposing to hydrogen requires an economic and technical appraisal however, deployment of heat pumps can progress alongside a targeted building efficiency programme.
- **Transport** – Electrification will play a key role in the decarbonisation of transport and an effective EV charging infrastructure is required. This is likely to embrace home and public charging and rapid charging hubs, together with chargers provided by business for the sole use of their customers and/or staff. A clear strategy for Northern Ireland is required urgently and should be the remit of a Government-led EV Taskforce which should also consider appropriate funding and pricing mechanisms.
- **Opportunities for Jobs and Skills** – Industry and the Northern Ireland Executive must maximise investment in skills and re-skilling initiatives to deliver the jobs needed to address Net Zero goals. It is envisaged that the transition will present opportunities in operational, engineering, construction, surveying, customer service, environmental, digital and specialist services.
- **Challenges for a Green Recovery** – The CCC has set out six principles to guide an economic recovery from the Covid19 pandemic: *(i)* Use climate investments to support the economic recovery and jobs; *(ii)* Lead a shift towards positive long-term behaviours; *(iii)* Tackle the wider 'resilience deficit' on climate change; *(iv)* Embed fairness as a core principle; *(v)* Ensure the recovery does not 'lock-in' greenhouse gas emissions or increased climate risk and *(vi)* Strengthen incentives to reduce emissions when considering fiscal changes.
- **Utility Regulator and Planning Service Dependencies** – to ensure efficient and timely delivery of projects on the ground will require a) a more proactive role for the Utility Regulator against an enhanced mandate to include decarbonisation objectives and the economic development of Northern Ireland and b) a revised approach for the Planning Service for approvals in a consistent and timely manner.
- The current Northern Ireland planning processes should be revised to ensure renewable infrastructure projects and other major grid projects are brought forward quickly and that NIE Networks can make anticipatory investments in the network now, ahead of future need and demand.
- **Conclusions** –
  - Energy transition in Northern Ireland must be on a fully integrated basis across all sectors taking account of our obligations within the UK Net Zero framework;
  - The Northern Ireland citizen should be educated, enabled and empowered to make the transition in as seamless and cost-effective way possible. Measures are needed to support vulnerable customers and the fuel poor through the transition;
  - Northern Ireland should have targets consistent with the CCC 6th Carbon Budget i.e. 82% reduction in GHG by 2050 and Net Zero CO_2 by 2050. It is possible for the power sector to decarbonise sooner;
  - Northern Ireland should set a minimum of 70% consumption of electricity from renewable energy by 2030 and promote a wide range of diverse renewable technologies including off shore wind;
  - Energy efficiency first - Promote energy efficiency and demand reduction through customer education and advice programmes, consolidating the positive behaviours from the pandemic, building retrofit programmes and shift to public transport;
  - Decarbonising heat – Setting end dates for fossil fuel boilers in new homes, promotion of low carbon heating (heat pumps) in new and off gas grid dwellings and commence this work now;
  - Decarbonising transport – setting end dates for new petrol and diesel sales in Northern Ireland and kick start the electric charging infrastructure industry that is urgently needed;
  - Broader remit for Utility Regulator to promote decarbonisation and economic development;
  - Develop the skills and employment base in Northern Ireland – through STEM education programmes and support for significant reskilling opportunities.

9.1 CREATING ECONOMIC OPPORTUNITY

Energy impacts all aspects of our daily lives, underpins all sectors of the Northern Ireland economy and is a key part of national infrastructure. NIE Networks already works with a range of companies, industries, local councils, academia, government departments and of course the Utility Regulator for Northern Ireland to support growth and development of the economy. As such, we are well placed to take a 'facilitator' role as the Northern Ireland Executive makes policy and legislative decisions which ultimately will act as a catalyst to drive forward economic and green opportunities in Northern Ireland to the benefit of all citizens on the transition to a Net Zero economy.

NIE Networks is fully supportive of the DfE's Energy Strategy process and are committed to working collaboratively with Utility Regulator, SONI and other stakeholders as part of that process. We have previously set out our thoughts on opportunities for the development of energy policy in response to both the DfE's Call for Evidence and the subsequent Economy Committee's Micro Enquiry.

With the right policy and regulatory framework, attracting private sector investment, clean energy can drive economic growth and job creation in Northern Ireland while maintaining affordability for customers – a virtuous cycle *(Figure 43)*.

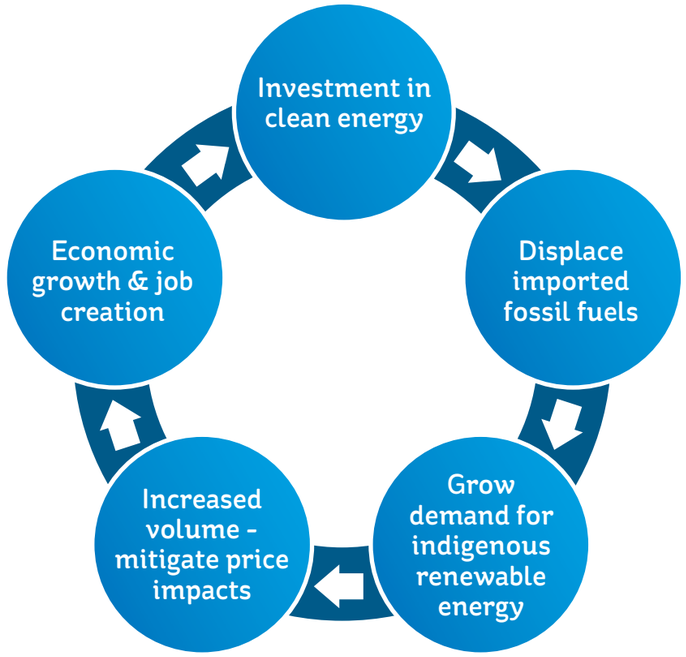


Figure 43 – The Economic Cycle

9.2 SUPPORTING THE CUSTOMER

It is vitally important that whatever steps are taken to support a green economic recovery and the energy transition, the needs of customers are met, both now and in the future. To do so, there is an urgent need to advance initiatives for greater engagement with and the involvement of communities and customers. Simple, impartial advice mechanisms for information sharing and support for community energy projects are all needed.

Measures are also required to support the most vulnerable in society, including financial support mechanisms. Studies have indicated that most people are happy to make changes needed to move towards a Net Zero carbon economy but they need help and advice on how to do so.

NIE Networks are mindful of the need for downward pressure on electricity costs for both commercial and domestic customers and that all policy must consider price impact. This document therefore sets out options that minimise the impact of costs whilst contributing positively to the economy.

9.3 INTEGRATED ENERGY SYSTEM WITH ENERGY EFFICIENCY FIRST

The coordinated planning and operation of the energy system across multiple energy carriers, infrastructures and consumption sectors can efficiently deliver a pathway to an affordable and decarbonised economy in Northern Ireland.

Approximately 68% of Northern Ireland's GHGs come from energy including power generation, transport, residential and industrial demand such as heating. The continued decarbonisation of power generation through the increased use of renewables, together with using that clean electricity to replace fossil fuels in heat and transport, can play a major role in addressing that 68% segment of GHG emissions.

However, other solutions will be required also and collaborative working across energy sectors is needed to develop complementary energy strategies. The hydrogen economy for example presents a huge opportunity for the UK to take a global lead on a key zero carbon technology. Hydrogen is not yet a market-ready solution of scale, but it has the potential to play a major role in decarbonisation in the longer term. However, hydrogen should not be perceived as an alternative to, or in competition with, renewable electricity as a low carbon solution. Rather, both can be inter-dependent elements of an overall integrated clean energy strategy.

Renewable electricity, in which Northern Ireland has an abundance of potential, is likely to be the major source for producing 'green' hydrogen in the future. Equally, hydrogen has potential to have a role in providing storage and flexibility capability that a renewable power generation system will need in the longer term.

Although Northern Ireland has some unique characteristics, it is important that due regard is paid to the extensive research, analysis and advice that has been carried out in the UK and Europe. The climate change challenge is a global one and there has been significant consideration given in many other jurisdictions on best practice and optimal pathways from which we should learn. Specifically, the European direction[132] advocates the following approach which should be adopted.

- First – a more circular energy system with **energy efficiency** at its core: energy efficiency reduces the overall investments required and the costs of energy production. Utilising more efficient technologies can provide further efficiencies e.g. use of EVs rather than ICEs and heat pumps rather than fossil fuelled boilers;
- Second – a greater **direct electrification** of end user sectors: Electrification could result in demand doubling by 2050 but requires to be based on renewable energy; and
- Third – the **use of renewable and low carbon fuels including hydrogen** for end use applications where direct heating or electrification are not feasible: there are a number of end use applications where it may be more appropriate to use other low carbon sources including industrial processes, heating close to industrial centres, long distance transport, aviation and maritime.

In addition, a more integrated system will also be multi-directional in which customers play an active role in energy supply.

There is increasingly an immediate necessity to advance this journey so a pragmatic approach should be adopted which would see immediate plans for progress in areas which are capable of advancing presently in parallel with a commitment to developing options and business cases for other technologies not so far advanced.

- Energy efficiency schemes:
  - legislate through new building regulations for near zero carbon dwellings;
  - develop a range of finance packages such as grants for lower incomes and green mortgage deals for those more able to pay for building retrofit insulation schemes.
- Encourage electrification where this makes sense:
  - urgently address the EV charging infrastructure by proving the right direction and conditions for market entrants to provide charge points in homes and in public space across Northern Ireland;
  - encourage the development of a heat pump market in Northern Ireland targeted initially at new builds and off gas grid dwellings. This does not impact ongoing trialling of alternative for natural gas for those presently on gas that need a zero-carbon alternative in the future;
  - make it economic for people to connect to the network and to use electricity through rebalancing the carbon levies and more dynamic tariff offerings from suppliers.

9.4 COMMITMENT TO NET ZERO

Northern Ireland should take cognisance of the detailed and extensive work of the CCC which has assessed how Northern Ireland can make its contribution to the UK target for Net Zero GHG emissions by 2050 as outlined in the Climate Change Act 2008 *(as amended 2019)*. In this, the 'Balanced pathway' presents a credible route to decarbonisation and GHG emission reductions.

Current evidence and advice from the CCC in their 6th Carbon Budget states it would not be feasible for Northern Ireland to achieve Net Zero greenhouse gas emissions by 2050. Instead it recommends that an 82% reduction in all greenhouse gases in Northern Ireland represents equivalent effort and a fair contribution to the UK Net Zero target. This is primarily due to Northern Ireland's unique characteristics specifically around the challenge for the agricultural sectors which accounts for 27% of Northern Ireland's GHG emissions compared to the UK average of 10%. NIE Networks also note that the CCC advises that for Northern Ireland "the earliest credible year for Net Zero GHG emissions would be post-2050". A Climate Change Bill for Northern Ireland is due to be developed and NIE Networks would recommend that Northern Ireland should have clear carbon reduction targets in accordance with the CCC's 6th Carbon Budget. It should have interim targets and achievable long-term milestones at say 2030, 2040 and 2050 with interim emission reduction targets at a minimum of 5 yearly intervals. These should reflect Northern Ireland's unique characteristics and be backed up by a target to reduce all GHGs as soon as practical after 2050.This will ensure that all of Northern Ireland's emissions are covered as part of a contribution to Net Zero for the UK and it has its own specific pathway for Net Zero.

Energy strategy should be reviewed at regular intervals as technology and customer behaviours change.

9.5 POWER

The 2010-2020 SEF for Northern Ireland set an ambitious target for 40% of demand to be met by Renewable Energy Sources for Electricity *(RES-E)*. Northern Ireland was successful in achieving this target and latest figures show that for the twelve-month period ending December 2020, 49.2% of total electricity consumption was generated from renewable sources located in Northern Ireland. In the nine years from the

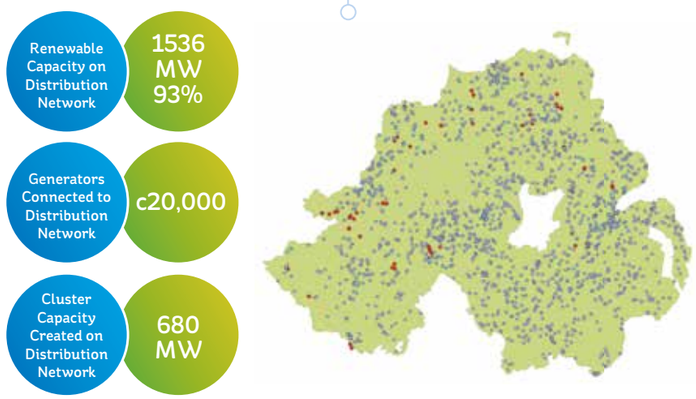


Figure 44 – Landscape of distribution connected renewables

publication of the SEF to 2020 the volume of renewable generation grew from approximately 450MW to 1,700MW. This represents nearly a fourfold increase in installed capacity of renewable generation at over 20,000 locations now connected to the electricity network.

It is also important to recognise the existing arrangements of the all-island I-SEM which went live in October 2018. Energy policy must enable an efficient, interconnected and harmonised energy market to operate on both sides of the border.

9.5.1 Grid Capacity

To facilitate increased renewable sources and electrification of heat and transport, it is essential that grid capacity is provided at a sufficient level ahead of need and to avoid having to upgrade capacity again prior to 2050. As a result of progress in connecting renewable generation, there is now limited grid capacity. NIE Networks together with the TSO have worked with industry to progress connection policy and steps have been taken to enable the connection of generators 5MW and above to the distribution system with non-firm market access. Non-firm offers are reflective of the transmission capacity or lack thereof, available to the generator. Issuing non-firm offers does not create more capacity or address the need for reinforcement; rather it allows generators to connect in anticipation of network reinforcement. We continue to work together to address connection policy for generators of less than 5MW seeking to connect *(and export)* onto the distribution system.

Five clusters were commissioned between 2012 and 2018, enabling approximately 500MW of renewable generation to be connected to the distribution system in Northern Ireland. In addition, two clusters enabling around 180MW of further renewable connections are at different stages in the development process. Cluster development is a working example of anticipatory development i.e. the need for a cluster is identified prior to the generation applications being received by NIE Networks. The success of the cluster methodology shows how successful anticipatory development can be when appropriate checks and risk management processes are put in place.

It is vitally important that policies and processes support the required sustainable infrastructure delivery.

9.5.2 Planning Process

Strategic grid infrastructure projects and renewable grid connections can face lengthy delays in the planning process. In Northern Ireland, the average planning time for major applications is 55 weeks, against a target of 30 weeks. In England and Scotland, the target for decisions on major planning applications is 13 weeks[133] and 4 months[134] respectively, with circa 90% of applications being met on time. Timelines in Northern Ireland are significantly longer than in other jurisdictions. Delays are largely caused by statutory consultees failing to respond against target timelines and a lack of local community support which results in issues for local councils.

NIE Networks are fully committed to ensuring best practice community consultation and recognises that without community support the delivery of new infrastructure projects becomes challenging. Nonetheless it must be recognised that the planning process and associated risks of legal challenge and delay represent a major challenge for the delivery of ambitious 2030 renewables targets. It is important to consider the planning process in Northern Ireland and to assess its suitability in light of the ambitious target likely to emerge from the energy strategy.

9.5.3 North-South Interconnector

The construction of the North-South Interconnector and wider network infrastructure development is urgently required to a) improve competition to enable more efficient operation of the market, b) improve security of supply and create resilience and c) improve the facilitation of renewable power generation to meet future targets.

The Interconnector is of strategic importance to join the transmission grid of Northern Ireland to the Irish transmission network enabling operation of an all-island system. At present, the lack of the second North South Interconnector is currently costing SEM customers in the order of €20m per annum and is limiting the efficiency of the wholesale energy market, and could become a barrier to potential investors given the need to increase the level of renewables on the system for a new RES-E target.

9.5.4 Smart Metering

Smart meters *(or intelligent meters)* have already been rolled out across Europe, with Italy, Sweden, Finland, Spain and Norway having reached close to 100% penetration. The Electricity Directive 2019/944/EC states that where the deployment of smart metering systems is assessed positively, at least 80% of final consumers shall be equipped with smart meters either within seven years from the date of the positive assessment or by 2024 for Member States that received a positive assessment prior to the implementation of Directive 2019/944[135]. Despite initial teething problems experienced in GB, BEIS is supportive of a continued roll-out, citing potential savings of £40 billion between now and 2050.

Modern, smart-ready technology is a key part of the drive to combat climate change. The information provided by smart meters will help customers to make more informed choices about their consumption, provide accurate and regular information on their energy usage, and ensure no more estimated bills. Smart meters are an essential foundation to maximise the benefit of renewable generation capability and LCTs, and offer customers information and choice such as availing of cheaper energy at off-peak periods.

These smart meters have the functionality to generate “big-data” - data that not only helps customers manage usage but also provides utilities with better information to manage system resilience and development. Use of this data allows cost-efficiencies and acts as a key enabler to future smart-cities and communities. This is currently not an option for Northern Ireland domestic customers, who have meters with very limited functionality. The blue-tooth unit for keypad meters currently available in Northern Ireland does provide additional information for customers and is a positive step in that regard, but it does not provide the full capability or benefits of smart meters.

NIE Networks considers it is time now to progress a smart metering programme as a key enabler and would support a review of the case for smart metering to ensure both customer and network benefits are assessed.

9.6 HEAT

We referenced in Chapter 5 that NIE Networks considers energy efficiency as a fundamental first step in reducing emissions. This is nowhere more relevant from a citizen’s perspective than in the amount of energy used in heating our homes.

As a matter of priority, the heating sector requires to a) modify Building Regulations to align with the ‘Future Homes Standard’ in the UK, ensuring that new homes built now will not need a retrofit in 15 years’ time and b) there is a significant and substantial building retrofit programme introduced in Northern Ireland.

There should be support for ‘low-regret’ heat technology in the early 2020s supporting a move away from oil boilers which are used in 68% of dwellings. NIE Networks would advocate the positions adopted in GB and RoI on the ban on oil boilers in new homes by 2022 (RoI) and gas boilers by 2025 *(RoI and GB)* as continued use of oil and natural gas is not consistent with a Net Zero agenda. NIE Networks considers that further extension of the natural gas grid should only be considered provided it has an economically favourable business case taking into consideration its future utilisation so that the Northern Ireland customers are not burdened with the cost of a stranded asset. The future of hydrogen is still uncertain and has many economic, technical and safety issues that need to be resolved. Therefore, a cautious approach should be adopted as in CCC 6th Carbon Budget proposals where the 2020s is still very much a trial period for this technology in the end use of home heating. It makes sense from a carbon emission perspective for current homes on oil to switch to gas where this is possible and economic for the customer and indeed utilising as an interim step the blending of natural gas with injection to the network of low carbon gases up to the technical capabilities of the network and end use appliances.

Alongside work on identifying zero carbon alternative to natural gas, there is a need to progress with least regret options of proven technologies such as heat pumps, commencing with new builds and as options initially for off gas grid customers. Coupled with an energy efficiency retrofit programme and an increasingly decarbonised electricity supply, heat pumps provide a 2020’s solution which is being adopted across Europe, Ireland and proposed by the CCC in the 6th Carbon Budget as the most significant contributor to heating decarbonisation for the UK. The heat pump industry *(and hybrid heat pump systems)* is in its infancy in Northern Ireland however the correct policy decisions should encourage the development of the market, suppliers and installers.

9.7 TRANSPORT

Responsible for more than 20% of all GHG emissions, decarbonising transport is one of the most important areas of climate action for Northern Ireland. This will need to include policy measures across both public and private transport as well as measures to encourage societal and behavioural changes in relation to the need for and use of transport.

It is widely accepted that electrification, i.e. using renewable electricity to charge battery powered vehicles, will play a key role in the decarbonisation of transport. Hydrogen is also likely to play a role particularly for larger vehicles that need to cover long distances.

To facilitate and support this transition in Northern Ireland, the most urgent action required is for a strategy to create a holistic EV charging infrastructure within Northern Ireland that will provide confidence to customers considering the purchase of an EV. The current EV

charging infrastructure is inadequate to support even the more modest scenario we have considered.

The charging network in Northern Ireland has remained free to use since it was developed. During this time, ESB ecars has subsumed all costs associated with providing charging services, including the cost of electricity, and maintaining the network in Northern Ireland. The current commercial model is not sustainable and does not enable further investment in the network. In the longer term, public EV charging infrastructure should be a commercial activity where users pay for the service and the revenues generated from usage enabling private sector investment. This would mean that the charging infrastructure would be commercially separate from the electricity network operator.

It is important that a holistic approach is taken to planning EV charging needs for Northern Ireland. A Council area by Council area approach is likely to lead to a patchwork network of inconsistent coverage across Northern Ireland and will be sub-optimal for the users. It is also important to have alignment with the infrastructure in RoI to cater for the very many cross-border journeys that motorists make.

An effective EV charging infrastructure for Northern Ireland is likely to consist of:

- Home Charging - individual 7kW chargers connected to the home installation of the EV owner;
- Public Charging - individual 7 to 50kW chargers located in public spaces *(similar to the current infrastructure)*;
- Rapid Charging Hubs - grouped 50kW *(Rapid)* to 350kW *(Ultra Rapid)* Chargers – the EV equivalent of a fuel filling station; and
- Destination Charging – individual or grouped 3.5 to 7kW – These chargers would be provided by business for the sole use of their customers and/or staff.

Home charging and destination charging are likely to be funded privately, with grant assistance where available. Significant progress has been made on some barriers with recent decisions by the Utility Regulator in respect of the cap on the retail price that could be charged for electricity at charge points. Further significant progress has been made by the DfI in respect of planning issues. The key barriers that remain are:

- a lack of a clear strategy – NIE Networks advocates that a Northern Ireland Cross-Departmental Government EV Taskforce is convened with representatives from key industry stakeholders such as motor distributors, infrastructure providers and representation from the Northern Ireland Local Authorities *(similar to the 'Plugged in Places' Programme)* to explore how best to set and move forward with Northern Ireland's EV ambitions including charging infrastructure.
- funding mechanism – the same taskforce should additionally explore funding options including:
  - Public / Private co-funding whereby matching funding from UK or Northern Ireland Government was made available to enable a commercial investment by ESB ecars or other private sector players;
  - Electricity Customer funding – whereby NIE Networks provides initial funding and recovers the cost from the general body of electricity customers through electricity bills *(as per the Derogation in the EU Directive)*;
  - Or a combination of the above two, where the NIE Networks / electricity customer funding is used instead of Government funding if that is not available, to partner with private sector funding.

Any solution will require the agreement of the DfI, and any funding solution involving NIE Networks and/or the wider electricity customers will require the agreement of the DfE and the Utility Regulator. The views of the motor industry, EV users, and other potential market participants should also be considered.

NIE Networks is willing to provide funding to support the delivery of an effective EV charging infrastructure for Northern Ireland, if that is the optimal policy option identified, subject to a regulatory recovery mechanism.

Whichever funding options are adopted, NIE Networks will work proactively to enable and support the delivery of an effective EV charging infrastructure for Northern Ireland.

9.8 OPPORTUNITY FOR JOBS AND SKILLS

DfE has engaged extensively across Northern Ireland in partnership with the Organisation for Economic Co-operation and Development *(OECD)* and published their research into skills and future job needs[136] with the number one issue for business was access to talent and labour. Statistics published recently show individuals claiming unemployment benefit are now exceeding 62,000 and proposed redundancies of over 9,000, double the number recorded in the previous twelve months[137].

The systemic issues that we need to address within our economy remain unchanged. OECD recognise that we still have too many in our workforce with no or low skills *(16%)*, low levels of productivity *(lowest in UK and RoI)*, low levels of in work progression and high levels of economic inactivity *(25%)*.

The energy transition will help to create new services, drive efficiencies and create opportunities for customers such as vehicle-to-grid charging and domestic aggregation. Industry will require the creation of new roles to take full advantage of new technologies, such as those using artificial intelligence or digital skills, which will require different combinations of competencies within the workforce.

The Energy Networks Association[138] predict that for the UK energy industry alone we can expect to see new job opportunities in a range of areas including:

- **Operational:** A green economic recovery will require more people employed on the frontline, operational activities – installing smart meters, new low carbon / hydrogen boilers, EV charge points and associated infrastructure alongside a much bigger province wide energy efficiency programme;
- **Engineering:** New roles will be necessary in every form of engineering including mechanical, electrical, structural, civil etc. Traditional craft skills will also be essential;
- **Surveyors:** As is the case with engineers, there will be a need for a full spectrum of surveyors, quantity and structural, capable of assessing the needs of both homes and infrastructure;
- **Customer service:** Following an acceleration of new products and services *(such as electric vehicle infrastructure and heat pumps)* there will be an increase in customer service opportunities to manage customer experience. We will also likely see an increase in the number of staff required to support vulnerable customers;
- **Environmental:** Infrastructure build-out at the scale needed will necessitate more environmental and ecological scientists as well as engineers and surveyors;
- **Digital:** To help us manage a future 'Internet of Energy' we will need staff with competencies in managing new data, cyber and artificial intelligence;
- **Specialist *(back office):*** As a result of new technologies and services, network companies, supply chain and new businesses will require staff with competencies in legal, compliance / regulation and supporting vulnerable customers.

It will be important to focus on maintaining sector attractiveness, recruitment and workforce diversity. Both industry and the Northern Ireland Executive must maximise investment in skills and support re-skilling initiatives to help us deliver the jobs needed while building public recognition of the careers available in the sector.

9.9 CHALLENGES FOR A GREEN RECOVERY

In its recent 6th Carbon Budget, the CCC has set out six principles to guide an economic recovery from the Covid19 pandemic:

1. ***Use climate investments to support the economic recovery and jobs***

   In its report the CCC states 'low carbon investment must scale up to £50bn each year to deliver Net Zero supporting the UK's economy over the next decade'. The role of electrification in decarbonising the power, heat and transport sectors will require significant investment but many of the projects required to enhance the grid to accommodate renewables and LCTs are presently near shovel-ready, many are labour-intensive and spread geographically across Northern Ireland and will have high multiplier effects for supply chains.

2. ***Lead a shift towards positive long-term behaviours***

   Experiences of behavioural change as a result of the pandemic which have had a positive impact on emissions can be embedded e.g. increased home working, remote forms of communication etc. The transition to LCTs such as EVs, solar PV, low carbon heat will lead to incremental behavioural change but the most significant behaviour in addressing the climate challenge is on energy efficiency and using less energy from whatever source. With the citizen at the centre of this transition, it is incumbent on government and industry to ensure citizens are educated in the options available to them, provided with the infrastructure, products and services to enable their transition to more efficient living and empowered to make choices in a just and fair manner.

3. ***Tackle the wider 'resilience deficit' on climate change***

   It is incumbent on policy makers, and for Northern Ireland specifically local government, to act with resolve to ensure comprehensive strategies and plans are in place against which a fair and just transition for the citizens of Northern Ireland can be understood and delivered on. This also needs to include an assessment of how the costs of the transition will be apportioned between the Exchequer, citizens through energy bills and private investment.

4. ***Embed fairness as a core principle***

   The current pandemic has arguably had the most detrimental impacts on lower income groups through issues such as access to IT for education and impacts on home heating for example. Without the correct design and consideration, these lower income groups could be potentially at risk in the transition to Net Zero. The benefits of the transition must be widely and proportionally spread and the costs must be attributed in a fair and just manner between those able to pay and those not.

5. ***Ensure the recovery does not 'lock-in' greenhouse gas emissions or increased climate risk***

   Decisions on low carbon investments should be contingent on them having real and lasting action on and being resilient to climate change. Decisions taken now will have cost implications to current and future Northern Ireland citizens for many years *(typically infrastructure costs are recovered over 40 years)*. The pathways chosen through policy direction and targets over the next decade must ensure that a) investments are targeted to those areas where the costs and benefits are known and understood, b) where there is a high degree of technical certainty in the solutions being adopted and c) they are consistent with achieving our Net Zero commitments.

6. ***Strengthen incentives to reduce emissions when considering fiscal changes***

   There are sectors presently which do not bear the full costs of emitting GHGs. Changes to fiscal policy can ensure this is rebalanced. For example, a) the climate change levy rate on the kWh price of electricity is 66% more than that of natural gas[139] and b) electricity suppliers include Northern Ireland costs for Renewables Obligation Certificates *(ROCS)* in their retail bills which gas suppliers do not[140]. *(The Northern Ireland Renewables Obligation (NIRO) has been the main support mechanism for encouraging increased renewable electricity generation in Northern Ireland[141].)*

NIE Networks supports the Northern Ireland Executive's medium-term recovery strategy 'Rebuilding A Stronger Economy'. It is recognised that there is a substantial economic recovery opportunity in decarbonising energy as part of growing the green economy across Northern Ireland. Clean energy is highlighted as one of the potential areas for growth.

The Energy Strategy process being led by DfE will provide long term direction for energy in the context of the UK target for Net Zero carbon by 2050. NIE Networks fully supports and is engaged with that process. However, we believe there are opportunities to accelerate some aspects of policy now to make progress in both economic and sustainability objectives in the short term.

NIE Networks has developed an eight-point plan[142] that aims to highlight specific areas for action required for Northern Ireland to hasten the journey to Net Zero, while at the same time unlocking economic potential in the aftermath of the pandemic. Our goal is two-fold; to enable Northern Ireland to tackle the climate emergency and to compete economically with our neighbours in the RoI and GB.

We believe immediate action is needed to generate momentum in this area. While the Energy Strategy process will determine the long-term direction and the policy mechanisms to achieve that, there are many decisions that could be made now to help make progress pending conclusion of that process. We focus on low risk and least regret options; tangible areas of opportunity to support the economy by unlocking investment in low carbon infrastructure and fast-tracking decarbonisation of heat and transport.

9.9.1 Joining up Policy and Regulation

Broadening the mandate of the Utility Regulator to consider the need for decarbonisation and economic development would provide an opportunity to create a forward-looking regulatory framework that supports innovation and strategic investment.

If the regulatory mandate permitted building infrastructure ahead of need, areas of investment in both the electricity grid and the necessary supporting telecommunications, IT and data infrastructure, could be identified and progressed. This would facilitate the accelerated development and uptake of LCTs and attract investors, all while delivering the best value for customers.

NIE Networks additionally advocates for a **review of connection charging policies** and regulations to align Northern Ireland with other regions, making it an attractive and competitive place to invest.

Through the joining up of policy setting and regulation, this would help Northern Ireland meet the long-term goal of Net Zero carbon, all whilst creating jobs and supply-chain opportunities and in turn energising cities, towns and villages across Northern Ireland.

9.9.2 Accelerating Investment in Renewables

Northern Ireland is a world leader in terms of renewable electricity generation with 47% of all electricity consumed in Northern Ireland now coming from renewable sources. NIE Networks has invested over £1 billion over the last decade to achieve this which has delivered significant economic and environmental benefits for the Northern Ireland economy.

We are advocating for the Northern Ireland Assembly to formally adopt the Economy Minister's proposed target of at least 70% renewable electricity by 2030.

Many renewable technologies no longer need substantial subsidies but they do need development of clear mechanisms to provide some certainty around market access and income streams to enable the investments to be bankable.

9.9.3 Network Infrastructure Investment

There is a substantial amount of investment still to be undertaken within the current regulatory price control which is due to run until 2024.

NIE Networks could scale up to deliver potentially an additional £50 million of work annually, supporting a significant local supply chain by working proactively to accelerate investment alongside other industry bodies. This would involve bringing forward key infrastructure projects currently planned for 2024-2026 to 2020-2023. NIE Networks and SONI are developing proposals which require a fast track approach to be adopted by both the Utility Regulator for approval and the Planning Service to ensure projects can be delivered on the ground efficiently. This could be in excess of £250m, including additional investment by wind developers, and the providers of other LCTs as well as additional investment by NIE Networks. Much of this investment will be regionally focused and will have a significant positive economic stimulus across all council areas in Northern Ireland.

9.9.4 Planning Process Improvement

The average planning timeline for major applications in Northern Ireland is 53 weeks, against the DfI's target of 30 weeks.

NIE Networks advocate for a **consistent and fast-tracked planning process** implemented for 'green development' projects which prioritises the efficient delivery of low carbon and renewable projects with appropriate targets, timeframes and accountabilities.

The current Northern Ireland planning processes should be revised to ensure renewable infrastructure projects and other major grid projects are brought forward quickly and that NIE Networks can make anticipatory investments in the network now, ahead of future need and demand.

9.9.5 Low Carbon Transport

Decarbonising transport in Northern Ireland would be transformative for not only the environment but for the economy and the creation of jobs.

In the immediate term, developing an ultra-rapid charging hub infrastructure across Northern Ireland would arguably have the biggest impact in terms of economic stimulus, due to the high investment costs and promotion of the electric vehicle sector. Almost twice as many EVs were sold in 2020 as there were in 2019 which is prompting calls for the need for more public charging infrastructure.

An initial emphasis on the delivery of electric vehicle charging infrastructure is also required specifically to help revitalise areas which have suffered from poor transport infrastructure.

Whilst welcoming recent developments such as the Interreg funding for a quantity of rapid chargers in Northern Ireland and by ESB to upgrade the existing EV charging infrastructure, in the absence of other players, NIE Networks is prepared to **kick start the provision of electric vehicle charging infrastructure** and finance the investment, if there is no viable market alternative.

This would require approval from the DfI and agreement with the Utility Regulator on funding mechanisms.

9.9.6 Digitalisation of the Energy Industry

Digitalisation of the energy system is central to the journey to Net Zero carbon with the data generated key to supporting climate change ambitions. Data helps network operators manage the systems more efficiently and helps customers make more informed choices about their consumption.

Smart meters have been rolled out successfully across many European countries but are currently not an option for Northern Ireland domestic customers, who have meters with more limited functionality. The introduction of smart meters would provide customers with the energy usage information they need to be more energy efficient and save money.

NIE Networks advocates for the DfE to update the business case for implementation of smart metering and to initiate a trial of significant scale for smart meters as part of an integrated solution for customers using LCTs.

9.9.7 Building Regulations

Preventing the loss of energy by **supporting energy efficiency** through modernisation of building regulations is essential. Through the building of advanced, sustainable and resilient housing infrastructure we can implement low carbon buildings now, thus avoiding the need to retrofit properties being built today in the years ahead.

Significant gains in this area can be made by **aligning Northern Ireland's building regulations** with those in GB and the RoI where progress towards near-zero carbon buildings has significantly progressed already.

9.9.8 Innovation

It is essential that we build on existing **innovation activities in low carbon energy** through increased government investment in areas such as large-scale trials of heat pumps, hybrid heating schemes, hydrogen electrolysis, smart metering and energy storage.

Developing the skills and local knowledge around such innovative technologies will encourage the adoption of new technologies amongst customers and ensure customers save money in the long term.

9.10 CONCLUSIONS

NIE Networks is supportive of a strategy which considers the energy transition in Northern Ireland on a fully integrated basis across all sectors taking account of our obligations within the UK Net Zero framework. This would enable Northern Ireland to play its part in the wider UK obligations under the Climate Act and the Paris Agreement.

NIE Networks note that the DfE's Energy Strategy and DAERA'S Climate Action Bill should dovetail as one and are heavily dependent on each other. To realise the full potential of Clean Energy for the Northern Ireland economy will require action and input from the Northern Ireland Executive, the UK Government, the Utility Regulator as relevant to the NIE Networks business, and all industry participants. NIE Networks is willing to work with all stakeholders to help advance a Climate Change Bill and we believe a sense of urgency is needed to generate momentum in this area.

There are significant challenges ahead for Northern Ireland in setting a strategy and delivering against that strategy if we are to decarbonise our economy and society in a fair and just manner. The guiding principles should be:

- Customer focused – The Northern Ireland citizen should be educated, enabled and empowered to make the transition as seamless and cost-effective as possible. Measures are needed to support vulnerable customers and the fuel poor through the transition which will only be possible if citizens are front and centre of this journey with significant engagement. NIE Networks continues to develop its extensive Stakeholder and Customer engagement plans;
- Setting targets through legislation - Set targets for Northern Ireland consistent with the CCC 6th Carbon Budget;
  - 82% reduction in GHG by 2050;
  - Net Zero carbon by 2050;
  - In addition, a target for Net Zero power sector by 2050 with an aim to decarbonise earlier; and
  - Set a minimum of 70% consumption of electricity from renewable energy by 2030 and promote a wide range of diverse renewable technologies including off shore wind.
- Energy efficiency first – Promote energy efficiency and demand reduction through customer education and advice programmes, consolidating the positive behaviours from the pandemic, building retrofit programmes and shift to public transport;
- Decarbonising heat – Setting end dates for fossil fuel boilers in new homes, promotion of low carbon heating *(heat pumps)* in new and off gas grid dwellings and commence this work now;
- Decarbonising transport – setting end dates for new petrol and diesel vehicle sales in Northern Ireland and kick start the electric charging infrastructure industry that is urgently needed;
- Enhancing the Regulatory framework – Broader remit for Utility Regulator to promote decarbonisation and economic development, ensuring a consistent framework to enable financeable and efficient regulated investment and promotion of appropriate market structures to attract capital in unregulated markets; and
- Develop the skills and employment base in Northern Ireland – through STEM education programmes and support for significant reskilling opportunities.

There is increasingly an awareness that the clock to 2050 is ticking and we need to commence this journey with a sense of urgency. NIE Networks will work with all stakeholders to ensure it plays its part and enables the transition through development of the grid ahead of need.

Northern Ireland Electricity Networks

10. FEEDBACK

YOUR OPINION

In this strategy document, we have outlined a vision for an electricity network which can play a central role in enabling the transition to a Net Zero economy. We would like to seek your views or opinions on a number of key areas that have been presented.

Question 1.

We have outlined our DSO roadmap to 2050 with a view of how we see the network and our business evolving. Do you consider:

a) the vision is appropriate to meet a zero-carbon energy target?

b) we plan to address this at the correct pace?

Question 2.

Do you agree with the principle of energy efficiency first, followed by a significant role for progressing at pace with known technologies such as electrification in decarbonising the various sectors? Please outline your reasons for agreeing or any alternative views.

Question 3.

As part of our proposals for a Green recovery to revitalise the Northern Ireland economy and additionally make progress towards Net Zero society, NIE Networks has proposed a number of areas of action. We would welcome your views on the following areas:

- Do you agree that the mandate of the Utility Regulator should be expanded to include consideration for Northern Ireland economic development and decarbonisation plans and targets?
- What is your opinion on NIE Networks accelerating network investment projects to ensure network capability is provided in advance of identified need and in so doing providing much needed economic stimulus? If so, can you suggest specific projects or areas of investments you consider should be accelerated, that would benefit the green recovery and transition to Net Zero?
- Would a review of connection charging policy which socialises a portion of the cost of connection to the network, similar to GB and RoI, help stimulate economic growth and present a more level playing field for inward investment?
- What are your views on the current planning process and timescales for infrastructure delivery particularly for investments required to deliver on Net Zero ambitions? Please outline how these could be improved.
- What more could be done to stimulate market entrants to install EV charging infrastructure?

Question 4.

NIE Networks' traditional approach to network innovation has been to integrate suitably advanced smart and customer-based solutions trialled elsewhere within the industry into business as usual solutions. Do you think NIE Networks should expand its innovation and research horizon to consider more system-wide solutions that may be more appropriate within a Northern Ireland context?

Question 5.

As customers become more reliant on the electricity network and its resilience for home working, charging electric vehicles and heating their homes, should NIE Networks invest to enable the network to become more resilient and protect against extremely rare, but potentially widespread and protracted outages due to significant climate change weather events?

Question 6.

In terms of developing and operating a more flexible network:

- In the future, when procuring flexibility *(FLEX)* from customers do you think that NIE Networks should be required to prioritise customers offering services via low carbon means?
- What are appropriate considerations for achieving the right balance between adopting flexible solutions over creating additional capacity through traditional reinforcement?

Question 7.

Given the significance of the changes and role of electrification in a future decarbonised society,

a) to what extent should the wider cost of decarbonisation across the sectors be borne by electricity consumers?

b) what would be a fair balance between UK government funding, local government funding, private investment and consumers?

c) how would vulnerable customers be protected from an unjust cost burden but also share in the benefits?

Question 8.

Do you consider smart metering and provision of energy data is a key enabler to the energy transition?

Question 9.

Is there anything else you would like to provide by way of comment or feedback?

Please send any feedback by 11th June 2021 to the following address with subject title **'Networks for Net Zero'**

networkstrategy@nienetworks.co.uk

Northern Ireland Electricity Networks

11. APPENDIX

11.1 RULET (RURAL-LED ENERGY TRANSITION) – ULSTER UNIVERSITY CASE STUDY

Electrification of heat and transport, along with the need for more renewable generation to meet the UK Net Zero 2050 target, requires a significant increase in flexibility to maximise system efficiency and to complement output from non-dispatchable renewables like wind and solar energy. Flexibility can be derived from a range of sources, including supply-side assets like investor-owned, grid-scale battery systems, fossil generators and interconnectors; or from demand-side resources such as dynamic domestic demand enabled by new business models and consumer-owned LCTs *(smart immersions heaters, domestic PV, heat pumps, thermal / battery storage, EVs).*

Domestic electrical heating systems, combined with thermal storage and smart controls, and operated at scale, have the potential to create significant system value by managing high levels of wind penetration. Northern Ireland has world-leading levels of wind energy connected at network voltages *(33kV and below)* particularly in western counties. However, when wind generation exceeds electricity demand, the output from wind turbines is dispatched down through;

a) curtailment *(global / system-level, to keep System Non-Synchronous Penetration below 70%)* and;

b) constraint (local, due to network capacity limits).

In 2020, 465 TWh of wind energy, representing 15% of available wind with a retail value of over £80M, was dispatched down – effectively dumped. This level of turn down indicates an inefficient system with high levels of connection but poor integration of renewables.

The declining costs of domestic-scale LCTs means that with new market arrangements for demand response and Time of Use tariffs, even moderately affluent households will be able to own assets which will allow them to shift their consumption of grid electricity to off-peak / low-price periods. This creates a risk that those who are unable to flex demand because they are not homeowners, and/or have limited access to capital *(including homes at risk of fuel poverty – so-called 'left-behind households')* are disadvantaged.

Project Aim and Description

The RULET project aims to reduce or eliminate the risk of low-income households being left behind in the transition to smart, integrated energy systems by demonstrating the system value of smart, flexible heating systems in social homes.

The project will quantify the value which could be created by significant uptake of flexible, low-carbon electric heating in NI social housing, and integrating cheap, wind-dominated electricity. Smart energy demand in NIHE-owned homes, equipped with both standalone and hybrid heat pumps with thermal storage, could provide flexible load to make use of low- or zero-cost wind energy *(which might otherwise be dumped)*, alleviating fuel poverty and creating value for wind farm operators, electricity retailers, network and system operators and social housing landlords and tenants alike. At present no business model exists to monetise this value.

In this context, UU and NIHE are carrying out a joint research project to assess how electrical heating, energy storage and smart control technologies could create new business and ownership models for flexible heat demand in up to 100 NIHE-owned homes. The project involves a field trial of a range of domestic energy systems provided by project partners Climote, Grant Boilers and Sunamp. In parallel with the field trial, UU will work with NIE Networks and SONI to model the impacts of extensive uptake of flexible electrical heating systems in NIHE's c.80,000 dwellings; in particular, off-gas grid homes in areas of high wind penetration. Energia / Power NI has received regulatory approval to trial a new dynamic Day Ahead Market-based tariff, the first of its kind in Northern Ireland, which will allow NIHE tenants to take advantage of cheap wind energy to heat their homes.

Project Partners

UU SPIRE 2 Project	NI Housing Executive	Climote	Energia	UREGNI
Grant Boilers	NIE Networks	SONI/SEMO	Sunamp	NI DfC

11.2 SUSTAINABILITY ROADMAP

11.3 FLEX

In February 2021 NIE Networks launched FLEX, its £1.3 million project aimed at developing local Flexibility markets in Northern Ireland. This project places customer participation at its core and seeks to develop an alternative, cost effective solution to manage network congestion.

Flexibility is described as a customer's ability to adjust their energy consumption in return for financial reward and using Flexibility marks a significant milestone on NIE Networks' journey towards becoming a DSO. Progressing from its traditionally passive role, NIE Networks will now actively manage demand and generation on its network to maintain and enhance security of supply for its customers.

Customers connected in specific areas of the distribution network downstream from a part of the network which is congested or near capacity, can support their local network by adjusting their electricity consumption when network capacity margins are tight. NIE Networks has published seventeen network areas, dubbed Flexibility Trial Zones *(FTZs)*, representing almost 15% of all customers distributed across Northern Ireland, in which customers can participate through a competitive tender[143]. These can be seen in Figure 45.

Flexibility offers value in many ways by managing potentially infrequent peak demands that would otherwise trigger network reinforcement. As society moves away from its reliance on carbon, demands placed on electricity networks are forecast to grow rapidly and Flexibility can support NIE Networks in managing this. The inherent optionality offered by Flexibility affords engineers time to let trends develop so that investment decisions are better informed, ensuring continued customer value for money.

NIE Networks has designed its project based closely on learning from now business as usual flexibility operations by all six DNOs in GB, and supported by standardisation and good practice recommendations from the ENA's Open Networks Project.

As a neutral facilitator, NIE Networks is making markets and opportunities more accessible for consumers and 'prosumers' wishing to make greater use of their DERs. Financially rewarding customers for their services will push revenues back into local areas, supporting businesses, communities and financial cases for investing in flexible LCTs.

Removing barriers to entry will enable greater participation and promote competition in the delivery of Flexibility services, and NIE Networks has enabled its smallest domestic customers to participate through aggregation. This approach will unlock network capacity at a low cost and in a timely manner, facilitating the growth in demand as customers adopt LCTs supporting the transition toward a low carbon society.

NIE Networks has made up to £500,000 available during this trial period, scheduled to begin in October 2021, with interim results expected by the end of 2021. While testing local markets, the FLEX project will develop the end to end process for using Flexibility, including a bespoke communications system, ultimately integrating these within existing business processes following trial completion.

Figure 45 - FLEX Flexibility Trial Zones and Description

11.4 SOLVING CONGESTION MANAGEMENT USING BATTERY ENERGY STORAGE SYSTEMS – QUB CASE STUDY

Introduction

While it is clear that the increased adoption of LCT has the potential to create enormous financial opportunities for their owners, uncontrolled addition of these devices can lead to serious security and reliability issues in the operation of the power system. It is therefore imperative for system operators to actively engage with relevant stakeholders (e.g., customers, government, academia, etc.) to put forward policies and operating strategies for ensuring safe, secure and sustainable operation of the power system in the future. As part of the EU-sponsored SPIRE2 *(Storage Platform for the Integration of Renewable Energy)* project, this collaborative work between Queen's University Belfast and NIE Networks aims to investigate how storage devices can be incorporated into distribution networks for relieving some of the concerns caused by the indiscriminate addition of adjustable loads and LCTs.

Overview of test distribution networks

In order to obtain realistic results, this study is being performed on two 11 kV distribution networks *(network 1 and network 2)* located in Northern Ireland which contain connected, or proposed to be connected, distributed generation *(DG)* such as biogas, solar and wind.

Network Service Provision from Battery Energy Storage Systems

Network Problems Encountered from Increased Adoption of LCTs

As mentioned previously, the aim of this study is to investigate how battery energy storage systems *(BESS)* can facilitate the increased adoption of LCTs *(DGs and EVs)* in distribution networks while ensuring that the system continues to operate in a safe and secure manner. BESS can potentially increase the stability and reliability of the system by providing fast actions to manage any network congestion issues such as voltage violations and line overloading.

Using substation data provided by NIE Networks, the study has established that although network 1 does not experience any problem with the current levels of load and DG penetration, a 150% increase in the DG installed capacity would indeed cause excessive voltage rise issues to occur in the downstream portion of the network. Additionally, increased energy injections from the proposed wind generators also causes some sections of the network to experience overloading issues.

Similarly, substation data provided by NIE Networks was used for performing simulations on network 2 corresponding to a high deployment scenario of LCTs[144]. It was subsequently observed that several downstream sections of the network experience under-voltage issues for several evening hours of the typical day under study when demands for EV charging and heat pumps were high. Additionally, several lines near the substation were found to be overloaded at a particular time in the evening with heavy downstream loads.

Another problem commonly encountered in today's distribution networks are significant peaks and valleys observed in the net substation load profile owing to concurrent actions from DGs and EVs. For example, a number of PV systems injecting energy into the network during a particular hour of bright sunlight or a number of EV owners charging their vehicles simultaneously in the evening can cause significant network congestion issues. Since distribution networks are designed to accommodate peak load, such concurrent actions by DG or EV would entail major network reinforcement costs to allow such large power flows. This study therefore also investigated how BESS can be used for 'levelling' *(i.e., reduce peaks / valleys)* the net load profile at the substation and in turn enforce better utilisation of the existing distribution network assets.

Voltage Regulation and Line Overloading Management

Given that the power output from renewable DGs are low carbon and many have zero fuel cost, the aim of this part of the study was to explore how BESS can be used to ensure secure operation of the power system *(i.e., no voltages or line loadings to be beyond permissible limits)* while minimising the curtailment of renewable DG.

To perform this study, which focuses on over-voltage and line overloading issues encountered in network 1 as previously discussed, six storage devices were assumed to be integrated into the network adjacent to the wind generators. Several simulations were performed, with each corresponding to a given BESS penetration scenario where individual storage sizes were assumed to be a particular percentage *(ranging from 10%–30%)* of the corresponding on-site DG installed capacity. The resulting voltage and loading profiles associated with the problematic sections of network 1 are presented in Figure 46. As observed from the figure for the scenario with no BESS installed, all problematic sections have voltages *(in %)* and loadings *(in %)* that are beyond the permissible values of 106% and 100% respectively. However, it can be observed from Figure 46 that increased penetration of BESS acts to reduce the voltage and loading violations, with a 30% BESS penetration scenario being successful in removing all voltage and loading violations with respect to the 'no BESS' scenario. Note that all simulations were performed for a typical day in the winter of 2017 corresponding to the substation data provided by NIE Networks, with the results presented in Figure 46 associated with the hour during that day which reported the worst network violations.

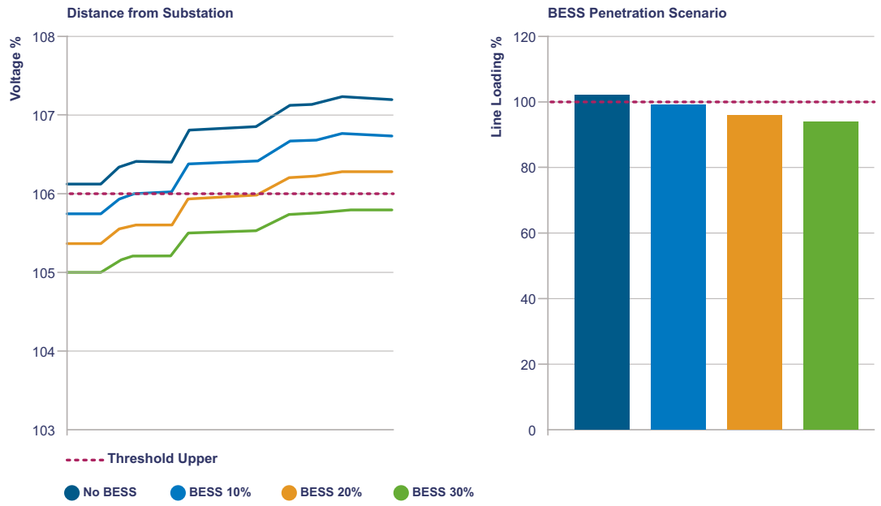


Figure 46 - Voltage and line loading profiles for violated elements in network 1

A similar case study was performed to examine the capability of battery storage devices to solve the network violations (under-voltage and line over-loading) identified for network 2, Figure 47 and Figure 48 illustrate the violations before and after incorporation of BESS. As observed from the figures, all violations experienced in network 2 during evening hours with high load *(e.g., from EV charging and heat pump operations*) are successfully cleared after the incorporation of storage devices.

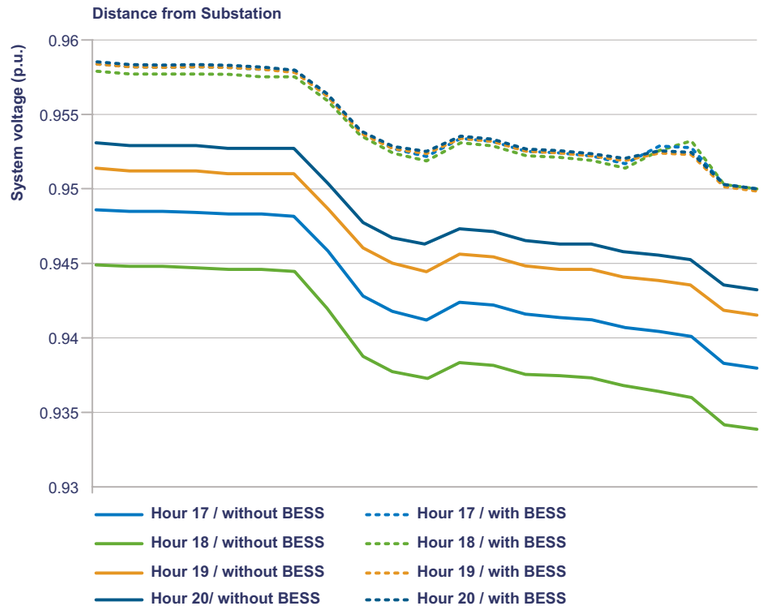


Figure 47 - Voltage violations in network 2 from 5:00 pm to 8:00 pm of the typical day under study

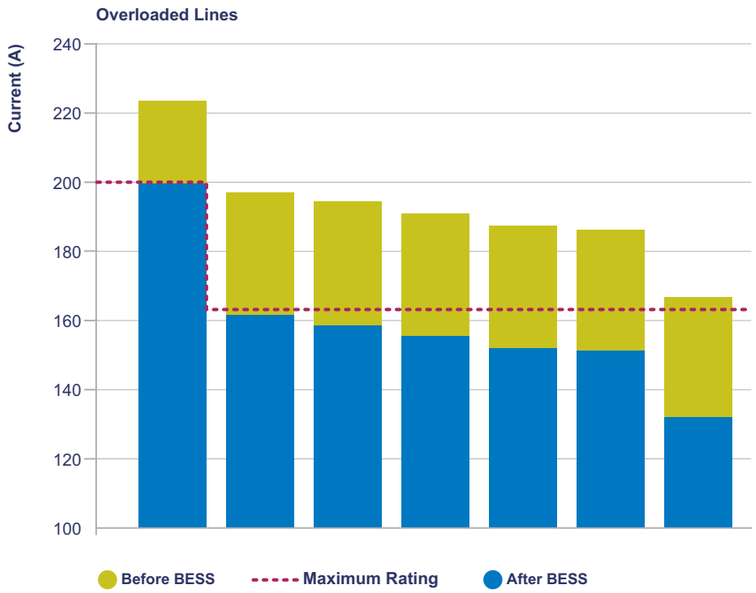


Figure 48 - Violated lines in network 2 at 6:00 pm of the typical day under study

Load Levelling

As previously discussed, another important ancillary service which BESS can provide is load levelling *(or peak shaving)* – a technique used to 'shave' the load from peak demand periods and shift it to off-peak periods *(night)*. Besides the benefit of lowering the electricity prices during peak periods, load levelling has proven to improve the network power quality, security and stability. Peak shaving is very important, especially during the winter, to provide the network with the necessary support during congestion periods. Load shifting is also advantageous for reducing the difference between the highest and lowest demand points which in turn supports network stability.

Several simulations were performed on network 2 to demonstrate the load levelling capabilities of BESS. The results are presented in Figure 49 and Figure 50 for typical winter and summer days, respectively. The figures illustrate how storage devices can inject power *(by discharging)* to shave the peaks during high demand periods and shift the shaved demand to off-peak times by consuming power *(charging)*.

Conclusion

Using substation data provided by NIE Networks, this study has demonstrated how BESS can facilitate increased adoption of LCTs in Northern Ireland's distribution networks while minimizing curtailment of renewable DGs whilst ensuring that the network continues to operate within safe and permissible limits. The study also shows how storage devices can be used for providing ancillary services in the network, e.g., load levelling, and subsequently helping to improve quality of supply to end users and enhancing network security and stability. By incorporating BESS, this work seeks to maximize the utilization of current distribution network assets which will have considerable benefits, largely economic, compared to conventional network reinforcement.

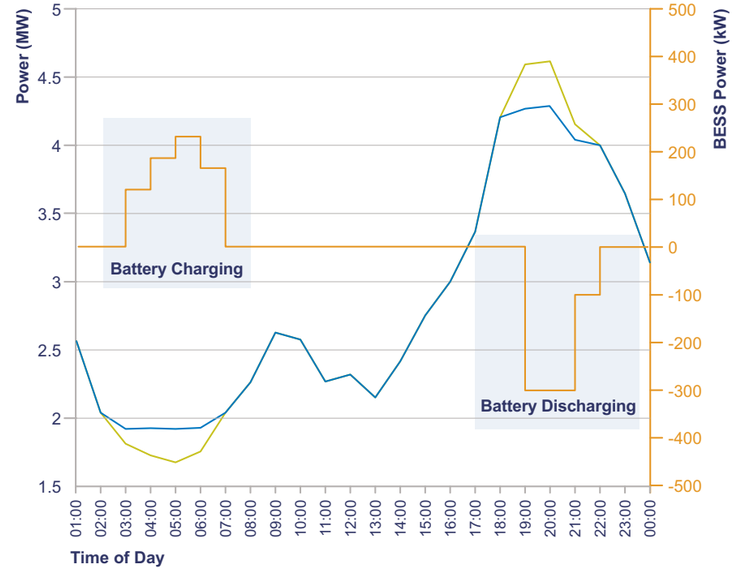


Figure 49 - Load levelling using battery storage systems during a typical winter day

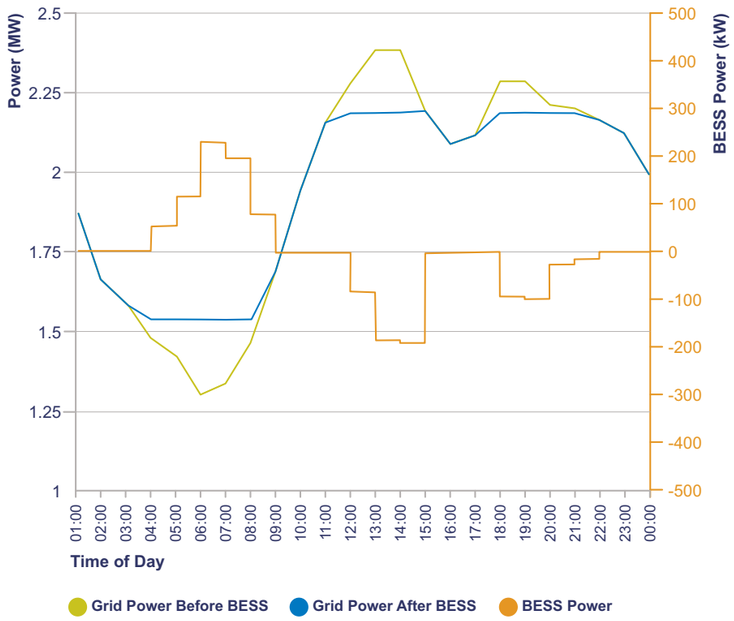


Figure 50 - Load levelling using battery storage systems during a typical summer day

12. GLOSSARY

Abbreviation	Meaning
BCF	Business Carbon Footprint
BEIS	The Department for Business, Energy & Industrial Strategy
BIC	Business in the Community
CCC	Committee on Climate Change
CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
DAERA	Department of Agriculture, Environment and Rural Affairs
DfE	Department for the Economy
DER	Distributed Energy Resource
DNO	Distribution Network Operator
DRVC	Demand Reduction through Voltage Conservation
DS3	Delivering a Secure, Sustainable Electricity System
DSO	Distribution System Operators
DUoS	Distribution Use of System
E.DSO	European Distribution System Operators
ENA	Energy Network Association
EPC	Energy Performance Certificate
ESOS	Energy Savings Opportunity Scheme
EUDSO	European Union Distribution System Operators
EU	European Union
EV	Electric Vehicles
FESS	Facilitation of Energy Storage Services
FTZ	Flexibility Trial Zones
GB	Great Britain
GHG	Green House Gas
HGV	Heavy Goods Vehicle
I&C	Industrial & Commercial
ICE	Internal combustion engine
IPCC	Intergovernmental Panel on Climate Change
I-SEM	Integrated Single Electricity Market
JWG	Joint Working Group
kV	kilovolt
kWh	kilowatt-hour
LCT	Low Carbon Technology
LV ANM	Low Voltage Active Network Management
MRP	Maximum Retail Price
$MtCO_2$	Metric Tonnes CO_2
MW	Megawatt *(1MW = 1,000,000 watts)*
MWh	Megawatt hours
NCF	Network Carbon Footprint
NIC	National Infrastructure Commission
NIRO	Northern Ireland Renewables Obligation
NIS	National Infrastructure strategy
NISRA	Northern Ireland Statistics and Research Agency
NSO	Normal System Operation
OECD	Organisation for Economic Co-operation and Development
PE	Polyethylene
PV	Photovoltaic
RAB	Regulatory Asset Base
RES	Renewable Energy Sources
RES-E	Renewable Energy Sources - Electricity
ROCs	Renewable Obligation Certificates
RoI	Republic of Ireland
RULET	Rural Led Energy Transition
SAM	Smart Asset Monitoring
SDG	Sustainable Development Goal
SEF	Strategic Energy Framework
SEM	All-island Single Electricity Market
SEG	Smart Export Guarantee
SONI	System Operator Northern Ireland
SPIRE 2	Storage Platform for the Integration of Renewable Energy
STATCOM	Static Compensator
STEM	Science, Technology, Engineering and Maths
TDPNI	Transmission Development Plan for Northern Ireland
TESNI	Tomorrow's Energy Scenarios Northern Ireland
TSC	Transmission System Charges
TSO	Transmission System Operator
TWh	Terawatt Hours
UK	United Kingdom
UN	United Nations
UoS	Use of System
ULEV	Ultra Low Emission Vehicles

Northern Ireland Electricity Networks

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