KPMG

Electrification: Economic Opportunity for Northern Ireland

Report for NIE Networks

—

July 2021

Contents

The contacts at KPMG in connection with this report are:

Russell Smyth
Sustainable Futures
Partner, KPMG Ireland

russell.smyth@kpmg.ie

Tomás Murray
Sustainable Futures
Director, KPMG Ireland

tomas.murray@kpmg.ie

Glossary of terms

BECCS	Bioenergy carbon capture and storage
BEIS	Department for Business, Energy and Industrial Strategy
CCC	Committee on Climate Change
CfD	Contract for Differences
COP	Co-efficient of performance
DAERA	Department of Agriculture, Environment and Rural Affairs
DEFRA	Department for Environmental, Food and Rural Affairs
DfE	Department for the Economy
EV	Electric Vehicles
GHG	Greenhouse Gas
GVA	Gross Value Added
GW	Giga-watt
HGV	Heavy goods vehicle
ICE	Internal Combustion Engine
ISEM	Integrated Single Electricity Market
kW	Kilowatt
kWh	Kilowatt hour
Mt	Mega-tonne
MW	Mega-watt
NfNZ	Networks for Net Zero
NI	Northern Ireland
NIA	Northern Ireland Assembly
NIHE	Northern Ireland Housing Executive
NISRA	Northern Ireland Statistics and Research Agency
PM10	Sub 10 micron particles
PV	Photovoltaic
RES-E	Electricity from renewable energy sources
TWh	Terawatt-hour
UK ETS	UK emissions trading scheme

01

Executive Summary

Executive Summary

Context

The Climate Action Bill 2019 set an ambitious target for the UK to reach net zero emissions by 2050. Net zero is transformative. Huge reductions are required in most sectors and though some emissions will still occur because the alternatives are so expensive, these emissions will need to be netted-out elsewhere through removal of CO_2 from the atmosphere.

The UK's early engagement with the subject of climate change displays significant leadership – almost all nations, including today's sceptics and laggards will ultimately align with this agenda. Achieving net zero GHG will require the alignment of all parts of the UK; the devolved administrations of Northern Ireland, Scotland and Wales between them control c.20% of all the UK's GHG emissions.

Northern Ireland has not set a 2050 target as yet, but the Climate Change Committee has recommended an 82% reduction (compared with 1990 levels) and DAERA has recently consulted on a climate bill that is planned to address this. In advance of a formal target, key NI government departments such as DfE have begun to develop the policy which will give rise to a major reduction in GHG emissions.

Introduction

NIE Networks have engaged KPMG to analyse the case for Electrification, which can be broadly characterised as the use of renewable electricity to supply heating and transport needs through heat pumps and electric vehicles. Electrification as considered therein does not represent the full suite of technological solutions required to give effect to an 82% reduction in GHG emissions. Other technologies such as biomethane and green hydrogen (although still somewhat immature) are also likely to play a significant role. The impacts of Electrification are analysed to 2040. This report considers the impact of Electrification on a standalone basis, and it does not provide a comparative analysis of one decarbonisation trajectory against another.

Vision for Electrification

The vision for an electrified economy considered to 2040 is closely aligned with that undertaken by Element Energy on behalf of SONI and NIE Networks in the development of SONI's *Tomorrow's Energy Scenarios* (Accelerated Ambition) and NIE Networks' *Networks for Net Zero* (World D) strategy documents.

- **Power sector:** A pre-requisite for decarbonisation through electrification is a power grid with a low and decreasing carbon-intensity. Last year 49% of electricity generated in Northern Ireland came from renewable sources - this scenario assumes that 80% of electricity is produced from renewable sources by 2030. Thereafter, it is assumed that renewables are added to the system to meet the additional requirements created by newly electrified end-uses. The power network infrastructure will also require significant investment to facilitate this transformation through additional capacity and more sophisticated control infrastructure.
- **Transport sector:** The purchase price of electric vehicles in comparison to conventional vehicles is falling. At the same time, a ban on the sale of new petrol and diesel units has been signalled post-2030. The combination of these effects is expected to push drivers towards electric vehicles to the point where they represent 84% of Northern Ireland's fleet by 2040. Although most charging is expected to take place at home, public charging points will also be required: an estimated 1,700-1,800 by 2030 rising to 5,500-5,600 by 2040.
- **Heat in buildings:** Emissions related to the heating of homes is one of the single biggest causes of GHG emissions. A disproportionate number of NI's homes are warmed through the combustion of oil and coal. Replacing boilers and solid fuel installations with high efficiency heat pumps, while upgrading the fabric of a building, presents a major opportunity for GHG reduction. An estimated 350,000 heat pumps could be deployed in homes by 2040.

Executive Summary

Investment Programme and Economic Impact

Electrification technologies are relatively expensive to install but are lower cost and less resource intensive to run, once operational. These technologies have a relatively long life, ranging from 15 years for heat pumps and EVs to 30 years+ for power network capacity and building fabric improvements.

The investment to support Electrification is estimated to be **£9.6bn**, equivalent to c.£500m per annum, in the period 2022-2040. Without doubt, this would constitute a major investment in the context of Northern Ireland's economy.

The benefit of reduced operational expenditure would be immediate and sustained for the duration of the investment's lifetime. KPMG estimate that Electrification would displace **£1.4bn** of annual expenditure on imported fossil fuels by 2040.

In addition to reduced operating expenditure, capital investment to effect Electrification would have indirect benefits – leading to an estimated total Gross Value Added of **£18.8bn**, i.e. indirect positive impact equivalent to the initial investment. The employment created from the capital investment programme is forecast to reach 5,000 FTE over the investment period.

Environmental Impact

Electrification is fully consistent with an 82% reduction in GHGs by 2050 and from that perspective it would deliver upon what is almost certain to be a core objective of the NI government. There are also other ancillary environmental benefits including reduced nitrous oxides, PM_{10} and sulphur dioxides which are the result of diesel, oil and solid fuel combustion. The deaths of 800 people in Northern Ireland each year are attributed to air pollution and the reductions expected from Electrification are significant in this regard.

Catalyst for Innovation

Northern Ireland already has a well-developed offering for businesses considering establishing a base in the region and there are a clear package of supports to turn research into profitable innovation. The scale of investment associated with Electrification, in the context of Northern Ireland's overall economy, create the opportunity for a transformative change that extends beyond the immediate impact of spending, to create a new export-focussed supply chain. There is already a significant level of local expertise in key areas of IT and engineering such as information security which will be fundamental to the development of the smarter energy system required to integrate new flexible forms of demand with relatively inflexible generation.

Conclusion

Electrification as considered in this report:

- **Addresses a key challenge:** Eliminating emissions from transport, heating and the power sector are key to achieving an 82% reduction in GHG.
- **Investment led growth:** Investment of c.£500m per year sustained over nearly two decades would create substantial employment opportunities in its delivery and establish a platform for export-led innovative growth in subsequent years.
- **Long-term benefits:** The impact of the investment in Electrification would be experienced immediately and would be sustained for decades to come.
- **Broader environmental and health benefits:** Air pollution from transport and home heating has major negative consequences for health outcomes in Northern Ireland and transitioning to a renewable and emissions-free model would benefit the entire population.
- **Proven technology:** All proposed elements of Electrification are fully proven and already deployed in Northern Ireland at some level. This allows policy makers to invest immediately and with confidence, ensuring Northern Ireland can start decarbonising immediately.

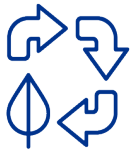
Overview

Decarbonisation of Northern Ireland's economy **is key to delivering future growth.**

Electrification of heating and transport can have a major impact on GHG emissions.

Electrification would be transformative for the economy, with significant capital investment, creating jobs and displacing imported fossil fuels.

Research clearly points to the negative health and environmental consequences of fossil fuel combustion. Displacement by renewable electricity can significantly reduce harmful emissions.



The paradigm shift that is Electrification of heating and transport will disrupt old models but with the correct supports this could lead to a host of innovative developments.

1. Proven technology capable of addressing decarbonisation of energy
2. Electrification requires a major capital investment programme that will reduce dependence on fossil fuel imports
3. Electrification can reduce environmental harm and improve health outcomes
4. Major electrification can be transformative for Northern Ireland and has the potential to catalyse a wave of innovation

02

Policy Context

National and International Policy Context

Paris Agreement

It is widely accepted that high levels of greenhouse gases in the earth's atmosphere are driving an increase in global temperatures. The Paris Agreement was negotiated by representatives of almost 200 nations at a conference held by the United Nations in 2015. It commits its signatories to holding the increase in global temperature well below 2°C and pursuing efforts to limit the increase to 1.5°C. As of March 2021, 191 nations including the United States, are parties to the agreement. The steps taken by each nation to give effect to a reduction vary and there is still some debate as to the emissions pathways which will credibly achieve the agreement's objectives. Most nations will take action voluntarily and those that do not will likely be pushed by others to do so.

UK 2050 Net Zero

The UK Climate Change Act of 2008 is the primary piece of legislation underpinning the UK's response to tackling its GHG emissions. It mandated a reduction of 80% in GHG emissions (vs 1990 levels) by 2050 and it established the Committee on Climate Change. The CCC is an independent, statutory body that's purpose is to advise UK and devolved governments on emissions targets and to report to Parliament on the progress being achieved.

In May 2019 the CCC recommended that the UK target Net Zero emissions (100% reduction compared to 1990) by 2050. This recommendation is based on evidence from a number of sources, particularly a report from the International Panel on Climate Change titled 'Special Report on Global Warming of 1.5°C'. Net Zero emissions is considered to be key to avoiding an increase in global temperatures beyond which there is expected to be a step-change in catastrophic environmental and social outcomes. The Climate Change Act was subsequently updated to give legal standing to the 2050 Net Zero target.

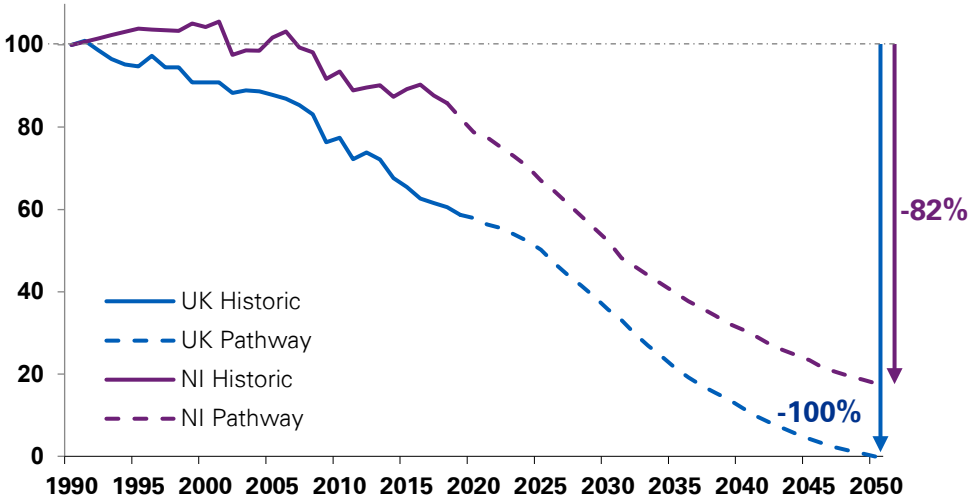
Net Zero does not mean that there will be no GHG emissions, but it does require that any residual emissions which are too expensive or difficult to avoid will be matched by eliminating an equivalent amount of GHGs from the atmosphere. This removal can be achieved through negative emission technologies such as bioenergy carbon capture and storage or by changing land use (e.g. planting trees) to sequester more carbon.

6th Carbon Budget

The 6th Carbon Budget sets out the CCC's recommendation on a GHG emissions pathway for the UK that is consistent with a Net Zero outcome. It covers the period 2033-37 and it recommends that UK-wide GHG emissions in 2030 are reduced by 68%, and further reduced by 78% in 2035 (both targets being relative to 1990 levels).

The CCC has also recommended 2050 targets for each of the devolved administrations, which hold responsibility for 20% of the UK's total emissions. The CCC recommended that NI sets an 82% reduction target. Net Zero for NI on a standalone basis is considered to be too demanding as agriculture (methane emissions) play a more significant role in its economy.

GHG Emissions (1990=100)



Source: Climate Change Committee

GHG Reduction Targets and Current Emission Sources

NI 2050 Targets

NI's total emissions were reported as 19.4Mt in 2018 by NISRA; this is equivalent to 10.3tCO_2eq per person. The NIA declared a 'Climate Change Emergency' in February 2021. While a specific GHG reduction target has not been set as yet, the Department of Agriculture, Environment and Rural Affairs have also published a '*Discussion Document on a Northern Ireland Climate Change Bill*' which will address this issue. It is considered likely that the final target mandated by the NIA in any such bill will be broadly in line with the recommendations of the CCC.

Sectoral Emissions

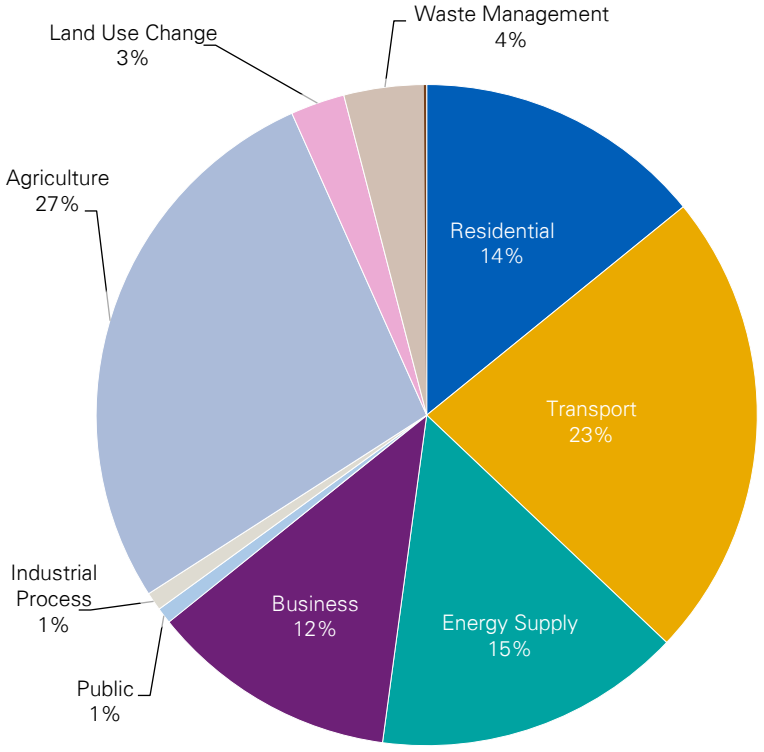
The role of agriculture in the broader economy has been recognised in CCC's recommended target but this sector will likely be required to effect significant reductions on the way to 2050; positive sectoral trends such as a 34% reduction in the carbon intensity of milk production since 1990 will need to be sustained. The remaining sectors where emissions are predominantly related to energy usage will need to deliver close-to 100% reductions.

Residential (14%) and Business (12%): Total residential emissions which relate mainly to building heat and household appliance consumption have remained broadly flat in absolute terms for the last decade, although decreasing on a per household basis. Oil is the fuel-source used to heat 2/3 of NI's households, with solid fuel still being used to heat almost c.3%of homes. Heating and cooling of commercial buildings represents 15% of business emissions – most of the rest of which are captured in the UK ETS.

Transport (23%): Total transport emissions decreased by 2% in the period 2008-2016. Emissions remain relatively high despite falling emissions intensity per km due to increasing car ownership. Commercial transport represents approximately a quarter of total transport emissions.

Energy Supply (15%): Significant progress has already been achieved with respect to NI's power sector; DfE figures show that 49% of all power delivered in NI in 2020 was produced from renewable sources. Increasing levels of renewable generation have decreased the overall system carbon intensity resulting in a reduction from 631gCO_2/kWh in 2014 to 339gCO_2/kWh in 2018 (DAERA intensity indicators). The non-renewable sources of power generation on the system predominantly relate to three major installations which are powered by gas (Coolkeeragh and Ballylumford) and coal (Kilroot).

NI GHG Emissions by Sector (2018)



Source: DAERA, NISRA

Electrification Technologies

The use of the term Electrification throughout this report refers to the use of three classes of technology to give effect to significant levels of decarbonisation of Northern Ireland's economy through the use of well-understood and rapidly deployable electricity-led technologies across power-supply, building heating and transport sectors to displace fossil fuels and reduce the combustion which gives rise to GHGs and other harmful emissions.

Heat pumps
Heating

Electrical heat pumps use a compressor to draw heat from a low temperature source, such as external air or the ground to heat the building interior. The device operates on the same principle as a household food refrigeration unit. Heat pumps operate at a high level of efficiency insofar as one unit of electrical energy can be used to derive 3-4 units of useful energy in a space heating or water heating application.

Heat pumps operate best in highly-insulated properties which retain energy – as opposed to poorly insulated homes where high-temperature heating units spike the temperature before the useful energy dissipates quickly through the fabric of the building. New buildings which are fitted with heat pumps typically install underfloor heating while older buildings may be retrofitted with low-temperature radiators as part of this process.

Electric Vehicles
Transport

Over the past decade the results of major innovations in battery and power train technology have accelerated the adoption of this formerly niche technology. Battery costs have fallen rapidly over the past decade to the point where they are now close to 10% of the equivalent price per kWh a decade ago. This decreasing battery price has made electric vehicles more affordable, decreasing the price premium versus an internal combustion engine ("ICE") powered unit.

Falling prices and increasing battery densities have also allowed cars with a greater range per charge to be built. Increasing ranges overcome one of the historical barriers to uptake – consumers' anxiety that their journey will be hampered by a lack of fuel when they require it. While public charging infrastructure will be required to facilitate the widespread roll out of EVs, the majority of charging is expected to take place at home.

Renewables
Power

The key assumption that underpins Electrification in this report is that shifting building heat and transport energy needs from fossil fuel sources to electrical energy sources is accompanied by a change in the power sector. In absence of major power sector decarbonisation, Electrification would merely shift emissions from one source to another. NI's progress on lowering power emission intensity is welcome, however additional generation capacity would be required to meet new sources of demand and all this must come from renewable sources.

The major paradigm shift in supply and consumption of energy would also require an upgrade of the power network, not just in terms of raw capacity which would need to increase but also in terms of the metering and control systems required to run match flexible demand with intermittent generation sources.

Decarbonisation Pathways

Energy Strategy to 2050

DfE has recently consulted on an number of issues relating to the development of an energy strategy for Northern Ireland. The consultation recognised the climate context in which it was set, framing its key objective as the delivery of "**Net zero carbon and affordable energy**". The consultation asked respondents for their views on a number of issues relating to: mechanisms for ensuring that energy continues to the affordable; ensuring that NI sees an economic benefit from the move to a zero carbon energy sector; and the possibility of extending the CfD scheme to NI.

The consultation also set out three energy-sector decarbonisation pathways for consideration. The purpose of consulting on these pathways was to develop 'low/no risk' options while retaining flexibility.

High Electrification: This scenario assumes that heat pumps provide the majority of heat to buildings and that the gas network is not expanded any further. Through a combination of regulations (ban on new petrol and diesel ICEs) and public infrastructure deployment, it is assumed that there is a significant uptake in demand for new electric vehicles. The system moves from 70% RES-E in 2030 to 100% in 2050.

High Gasification: This scenario focuses on the use of renewable gas for heating and transport applications. In a somewhat counterintuitive turn, this feature has a higher level of renewable generation in 2030 (80% RES-E) in order to generate green hydrogen. In this scenario the gas network is expanded while remote dwellings are fitted with heat pumps. Road vehicles are decarbonised through combination of electric vehicles and a high proportion of hydrogen-powered buses and HGVs.

Diverse: This scenario can be broadly considered to be an intermediate scenario sitting between the high gasification and high electrification scenarios outlined above.

Scenario Considered in this Analysis

NIE Networks published a strategy report entitled *'Networks for Net Zero' ("NfNZ")*, in which a number of possible decarbonisation strategies to 2050 were outlined.

The scenarios outlined in NfNZ were consistent with analysis carried out on behalf of SONI and NIE Networks by Element Energy under the DfE-supported Joint Working Group as well as work to support the development of SONI's *Tomorrow's Energy Scenarios for Northern Ireland* report.

The key sectoral assumptions that underpin the analysis in this report are set out in Section 3, however it should be noted that this analysis is intended to map to **Accelerated Ambition** and **World D** scenarios and including:

- High levels of heat pump uptake;
- 80% of electricity from renewables by 2030;
- Modest economic growth over the next decade, increasing towards the end of the period;
- A ban on new petrol and diesel cars by 2032, resulting in significant EV uptake;
- Adoption of Future Homes Standard to new homes and existing properties from 2025; and
- Achieves UK net zero emissions reduction contribution for NI set out by the CCC by 2040.

Other Technologies

While the analysis in this report considers the impact of a scenario that sees a significant deployment of Electrification technologies, this does not preclude other key technologies such as biomethane and green hydrogen from playing a major role. KPMG have concluded that there are certain applications for gaseous renewable energy in a decarbonised NI. The degree to which these technologies compete with Electrification technologies is still the subject of some uncertainty and will become clear as electrolyser and associated compression infrastructure reaches a higher level of maturity.

This report does not compare the benefits of Electrification to other decarbonisation scenarios, instead it sets out the impact of World D as per NIE Networks' NfNZ scenario compared to business as usual.

The analysis in this report runs to 2040 which is a recognition of the uncertainty regarding the optimal technologies to effect the final leg of NI's decarbonisation journey.

Electrification and an Energy Strategy for Northern Ireland

- **The vision of Electrification set out in this report is fully consistent with the objectives for an energy strategy set out in DfE's recent consultation.**
- **Electrification delivers avoided fossil fuel costs and a customer-centric model which is consistent with Net Zero by 2050.**

Placing you at the heart of the energy future	▪ Electrification of the Northern Ireland economy will put the customer at the centre by allowing them to engage with low carbon technologies such as electric vehicles, heat pumps and solar PV. ▪ Customers will have a major role to play in the operation of the new energy system by responding to price signals made possible through new smart technology lowering the cost of heating their homes and fuelling their cars.
Grow a green economy	▪ Electrification will require a major investment, calculated to be £9.6bn by 2040. ▪ This investment is forecast to create an average of 5,000 FTE roles over the period. ▪ This will significantly reduce dependence on imported fossil fuels (c.£1.4bn per annum reduction by 2040).
Do more with less	▪ The widespread deployment of heat pumps envisaged by NIE Networks goes hand-in-hand with a major upgrading of the region's building stock. ▪ The combination of high-efficiency heat-pumps (typically >300%) with improved building conditions is projected to reduce primary demand by c.9TWh per annum by 2040.
Replace fossil fuels with indigenous renewables	▪ NIE Networks' high-electrification scenario would see almost 4GW of additional solar and wind capacity installed by 2040. ▪ This incremental clean and renewable electricity capacity would initially displace imported petrol and diesel from Northern Ireland's roads as well as coal and heating oil from homes.
Create a flexible and integrated energy system	▪ The introduction of smart meters will provide electricity suppliers and their consumers with the tools to respond to price signals by scheduling consumption of their newly-electrified energy needs at times when it is cheapest to do so. ▪ A smart network to facilitate high electrification is also consistent with the emergence of a new class of consumer that is also capable of some degree of self-supply, even returning power to the grid at times of surplus.

03

Vision for Electrification

Introduction

An updated policy framework and a more dynamic electricity system are required to give effect to the Electrification scenario described in this report.

Policy Framework

Almost all analysis of GHG emissions in NI and UK is consistent in finding that a business as usual approach without reform of public policy will not deliver the changes required to achieve a Net Zero outcome. Policy reform in the following areas is considered to be the minimum required in order to effect the Electrification scenario:

Renewable Energy Support: Developers of renewable generation in NI are at something of a disadvantage in comparison to counterparts in Scotland, England and Wales or the Republic of Ireland as they cannot access a government-supported mechanism that provides price certainty on the output of their projects. The scale of investment in renewable power generation considered is unlikely to be delivered by the UK ETS system alone and would therefore require some sort of support. While a direct transposition of BEIS's contracts for difference to NI may not be the optimal approach, it would at least remove the biggest barrier.

Personal Transport: A ban on the sale of new petrol and diesel cars is set to come into effect across the UK in 2030, albeit there is an exemption for new hybrid vehicles until 2035. Implementation of this ban will be a major driver towards adoption of EVs however government intervention may also be required to ensure that the public charging infrastructure evolves in a co-ordinated and timely manner to support the expected shift.

Building Energy: NI's housing stock is projected to increase by 10% in this scenario in the period 2020-2040. Setting a higher standard for new homes in line with the UK's Future Homes Standard ensures that buildings are suitable for heat pump deployment from the outset. Deployment of heat pumps in existing homes would require an improvement of the building fabric in many instances. As any costs would be incurred up front and the benefits over a longer period government support for a suitable financing mechanism would almost certainly be required.

New Power System Paradigm

Electrification would see 50-60% more energy delivered through the power system by 2040. The nature of power supply would also change as carbon-intensive but highly controllable units give way to emissions-free but intermittent forms of generation. The net result is that the power system to accommodate the increased volumes will not only be larger, but also different in operation from its current configuration.

ISEM already provides electricity-suppliers with strong price signals, reflecting short term changes in the supply-demand balance. As the availability of supply becomes dependent upon prevailing weather conditions and the cost of back-up generation increases due to rising carbon prices, wholesale electricity prices are expected to exhibit broader levels of variation. That is to say, there are expected to be more periods of low / zero price than today but periods when supply capacity is short will be significantly more expensive. The incentive for suppliers to pass this volatility to their customers will increase, while some may find innovative mechanisms to manage this on their behalf. Smart meters will also increase the number of individual customers with an incentive to respond to price signals.

As the wholesale market provides stronger incentives to respond to changing supply-demand conditions, new forms of demand have an enhanced degree of controllability. For example, electric cars can be set to charge at times when wholesale power is at its cheapest; heat pumps integrated with smart controllers may slightly increase temperatures when it is cheaper, in contemplation of later periods of high prices.

The compound effect of price signals and an enhanced ability to respond may lead to short term spikes of activity on the distribution network. The role of the distribution system operator will need to evolve to support Electrification and dynamic network tariffs may be required to facilitate the connection of new forms of generation with new electrical loads. Active customers with onsite PV generation of their own and in some instances storage capacity can also play a role if thoughtfully integrated.

Power Generation Decarbonisation

Significant growth in renewable energy generation would be required to deliver Electrification on the scale envisaged in this report and deliver a reduction in emissions consistent with a Net Zero ambition.

Scenario

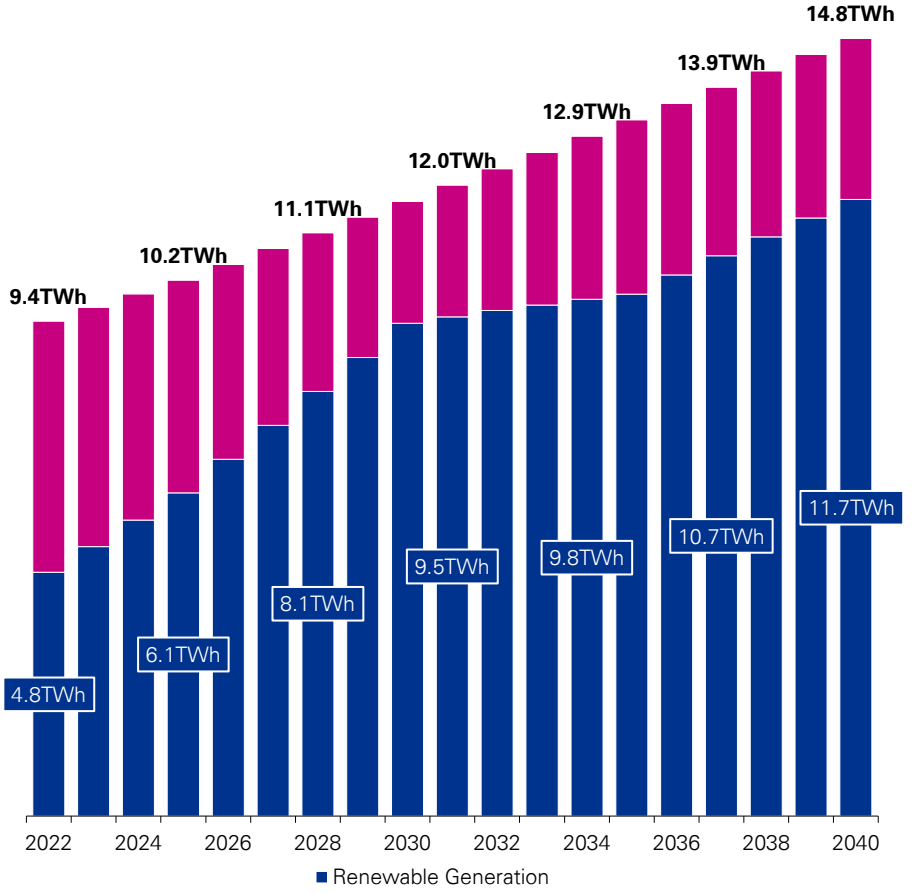
- For the remainder of the current decade renewable generation would increase its share of the overall power generation mix, displacing first coal and then gas from the merit order and reducing the carbon intensity of grid electricity.
- The power generation evolution considered herein would see renewable generation capacity provide 80% of all electricity by 2030 (consistent with SONI's accelerated ambition scenario).
- Post-2030 an expansion of generation capacity is required to keep pace with the growing demands of electrification as EVs and Heat Pump deployment gather momentum.
- By 2040 there would be 5.4GW of renewable generation installed including:
  - 1.6GW of solar PV (distributed generation and utility scale);
  - 850MW of offshore wind; and
  - 2.8GW of onshore wind.

Required Investment

- Capital spending of c.£4.0bn is projected to be required to deliver the required increase in renewable generation to 2040.
- Both the transmission and distribution networks would need to be upgraded and reinforced to ensure that significantly greater volumes of power can be delivered securely:
  - Distribution network capital expenditure of: c.£0.8-0.9bn[1]; and
  - Transmission network expenditure of £0.9-1.0bn[1].

(1) In both cases investment figures represent investment in excess of that required in a business as usual scenario.

Renewable Generation / Total Electricity Requirement



Source: SONI, KPMG Analysis

Electrification of Transport

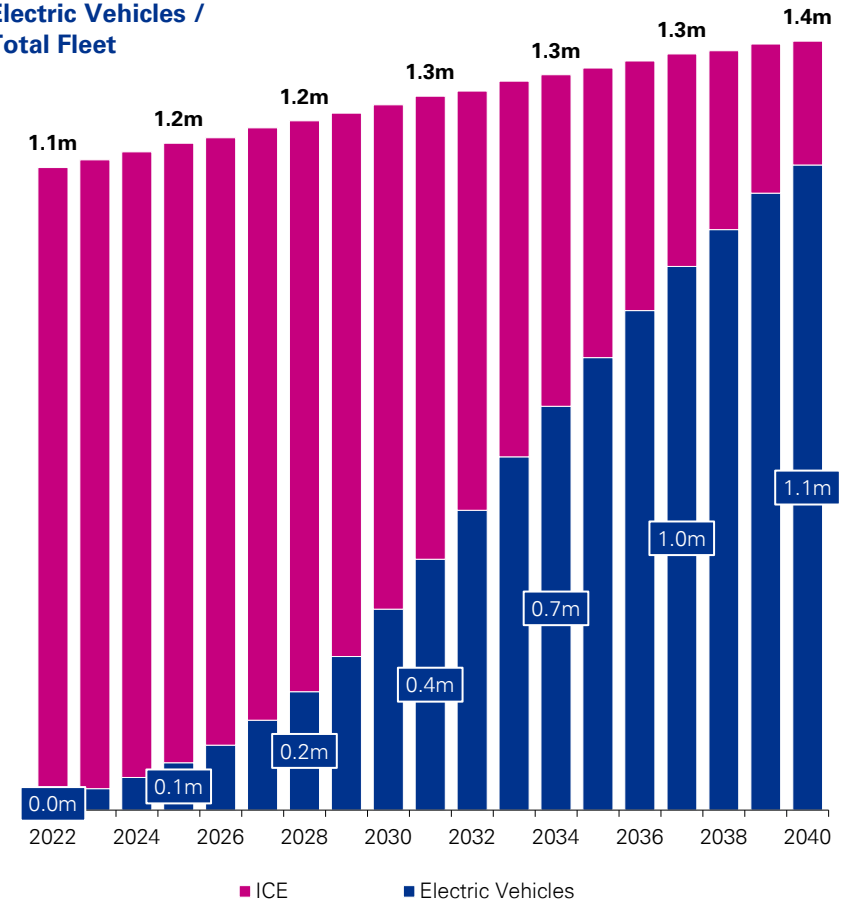
Scenario

- The total fleet of cars and taxis in NI is projected to grow at a rate of 1% per annum.
- By 2040 there are expected to be approximately 1.4m cars on NI's roads.
- EV's are not expected to represent more than 30% of new vehicles purchased until 2025 but towards the end of the decade electric vehicles are expected to represent the vast majority of new purchases.
- This sharp shift towards EVs is the result of:
  - **Improving Economics:** the cost of an EV is expected to reach parity with an ICE by 2030; and
  - **Regulation:** a ban on the sale of new diesel and petrol cars is projected for 2032.
- In the second decade, EV becomes increasingly dominant across the regional fleet as older cars are replaced.
- Public charging infrastructure is required to support this transport shift and analysis conducted by CCC suggests that 1.1m EVs would require approximately 5,500 chargers by 2040, including up to 50-100 units as large as 350kW.

Required Investment

- Incremental spending on electric vehicles, which is modelled to be £260m in comparison to BAU represents a small part of total impact as the cost premium to ICE is assumed to persist only until 2030. From that point on all spending on EV in the high electrification scenario is equivalent to what would otherwise have occurred.
- Investment in the order of £200-250m on charging infrastructure is forecast to be required to support the transition of ICE to EVs.

Electric Vehicles / Total Fleet



Source: Element Energy, KPMG Analysis

Electrification of Heating

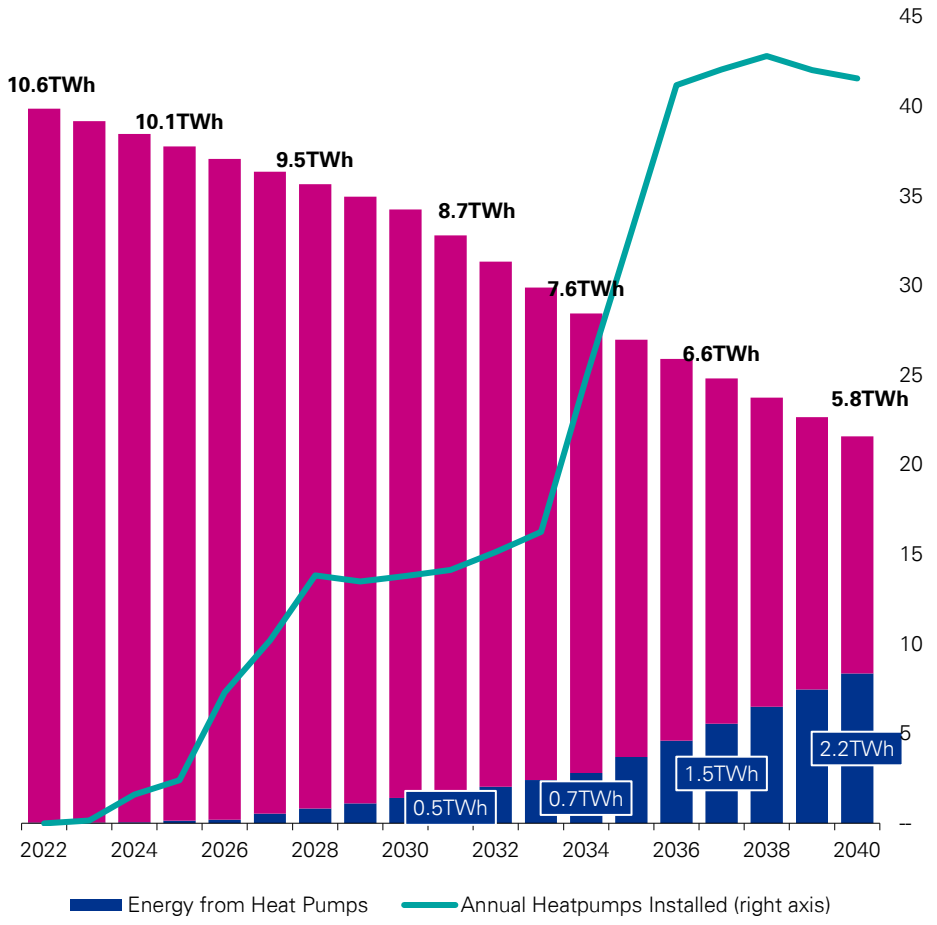
Scenario

- The Electrification scenario considered in this report would see heat pumps in c.350k dwellings by 2040, which is equivalent to a heat pump in 40% of homes in NI.
- Heat pump installation is expected to remain low until the middle of the decade when they become the main heating source for new-build homes. The major increase takes place towards the end of the second decade, where the majority of domestic heat pumps are installed in existing homes.
- Heat pump COP is modelled to be in the range 2.5-3.0, in line with modelling assumptions used by the CCC to inform the 6th Carbon Budget.
- Existing homes where heat pumps are fitted are also assumed to undergo broader energy efficiency upgrades, including: roof and loft insulation; wall insulation; radiator upgrade; floor insulation; and window upgrades where double-glazing is not already present. In addition to the reduction in primary energy demand through using heat pumps, the associated energy efficiency will also deliver savings to the homeowners.
- While the majority of heat pumps are expected to be deployed in a residential setting, c.25k commercial premises are also expected to have these units and where appropriate also undergo upgrades to the building energy fabric.

Required Investment

- Combined residential and commercial heat pump capital investment in the period 2022-2040 is projected to reach £0.6bn.
- Energy efficiency upgrade spending in residential buildings in the same period is expected to reach something in the order of £2.5bn, which is equivalent to c.£7k per installed residential heat pump. This figure is a KPMG-estimated derived from building stock data published by NIHE.
- Energy efficiency spending to support heat pump deployment in the same period is projected to be c.£0.3bn.

Heat pump Energy(TWh) / Installed Heat pumps



Source: Element Energy, KPMG Analysis

04

Economic Impact

Incremental Capital Investment

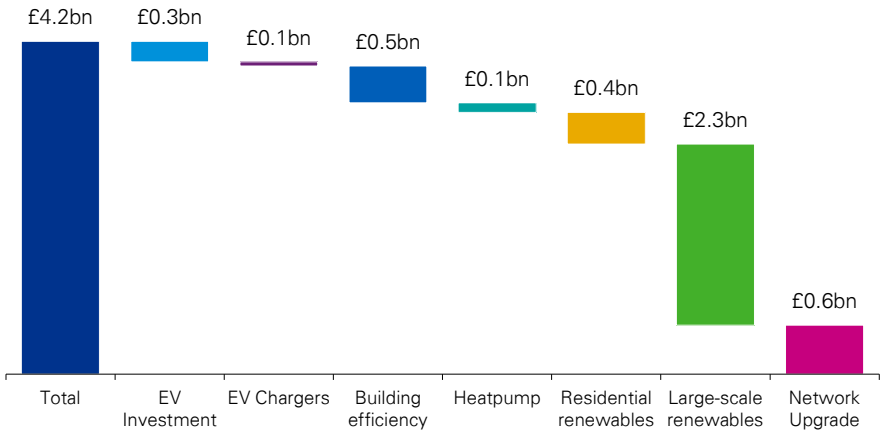
Incremental capital investment to deliver an Electrification scenario to 2040 as outlined in the previous section is calculated to be £9.6bn (average annual investment of c.£0.5bn). KPMG note that this figure is significant in the context of NI's economy:

- Annual R&D spending by NI businesses was £630m in 2019 (NISRA); while
- Total NI business turnover was £72bn in the same year (NISRA).

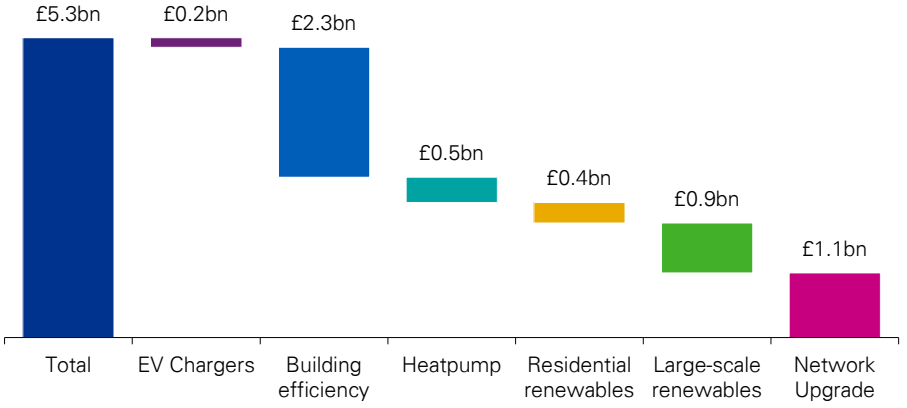
Electrification technologies are characterised by reasonably high upfront costs and low or zero marginal costs thereafter. Heat pumps and cars are among the items with the shortest lifespans (c.15 years); renewable generation assets have a lifespan in order of 25-30 years; while power networks and energy efficiency upgrades will deliver benefits for 35 years+. The capital investment programme outlined herein needs to be considered in the context of the horizon over which its benefits will be realised.

- **Large-scale renewables:** This is the single largest investment category at £3.2bn.
- **Residential renewables:** Almost 0.5GW of residential solar PV is considered in this scenario resulting in capital expenditure of £0.8bn.
- **Network Upgrade:** The upgrade to the power network infrastructure to support this level of deployment is modelled to be c.£1.7bn; it should be noted that this represents the incremental expenditure required over and above business as usual.
- **Building efficiency and Heat Pump:** These combined categories represent approximately 1/3 of total investment and while the investments are related, there is an energy (and emissions) reduction that can be separately attributed to each category.
- **EV and associated charging network:** Incremental investment on the electrification of personal transport is relatively small in the period as EVs are expected to have reached price-parity with ICEs by the time they begin to represent the dominant choice for new vehicle purchases.

Incremental Capital Investment, 2022-2030 (£bn)



Incremental Capital Investment, 2031-2040 (£bn)



Source: KPMG Analysis

Economic Impact of Capital Investment

Employment

The capital investment programme outlined on the previous page is noted to be significant in the context of the NI economy. A significant portion of the investment in these projects will relate to construction labour and there will be further positive impacts on the economy as secondary and tertiary roles will also be required to support this economic activity.

KPMG has conducted an analysis of similar, albeit smaller, initiatives in other jurisdictions.

- £1m spent on energy efficiency in a year leads to 11 FTE being sustained for a year; while
- £1m spent on power generation projects leads to c.10 FTE in a year.

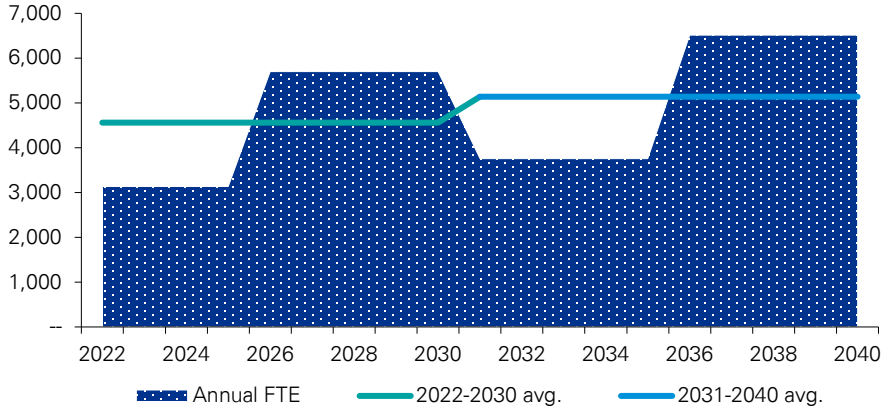
On this basis it is estimated that investment of £9-10bn over the period 2022-2040 will result in c.5,000 roles being sustained. It should be noted that this figure is gross and does not reflect: (a) any ongoing roles related to the maintenance or operation of new equipment; (b) roles displaced through reduction in fossil fuel importation; or (c) roles created in export-focussed innovative businesses that emerge as a consequence of this major investment programme.

Gross Value Added

In addition to increased levels of employment, investment in Electrification will propagate throughout Northern Ireland. KPMG have disaggregated the projected spend into statistical subcategories that are consistent with NISRA's own spending categories, and using economic multipliers also developed by NISRA estimated the impact on GDP.

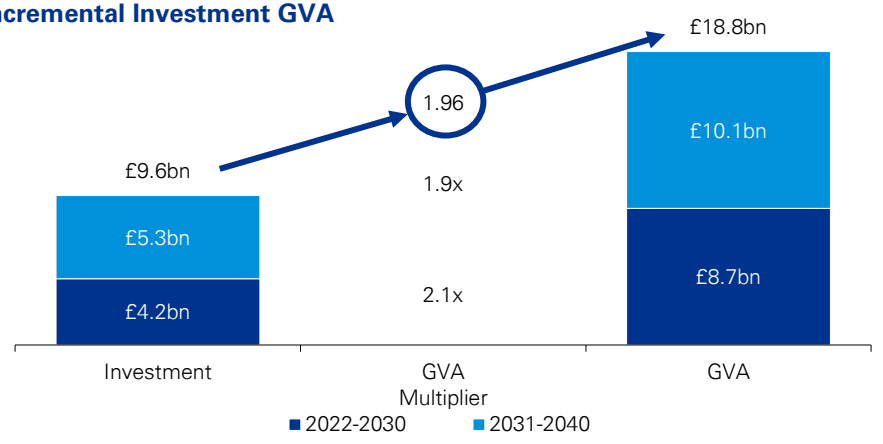
- Each £1m spent on the Electrification programme is projected to deliver £1.96m of value across the NI economy.

Employment from Incremental Investment (Annual FTE)



Source: KPMG Analysis

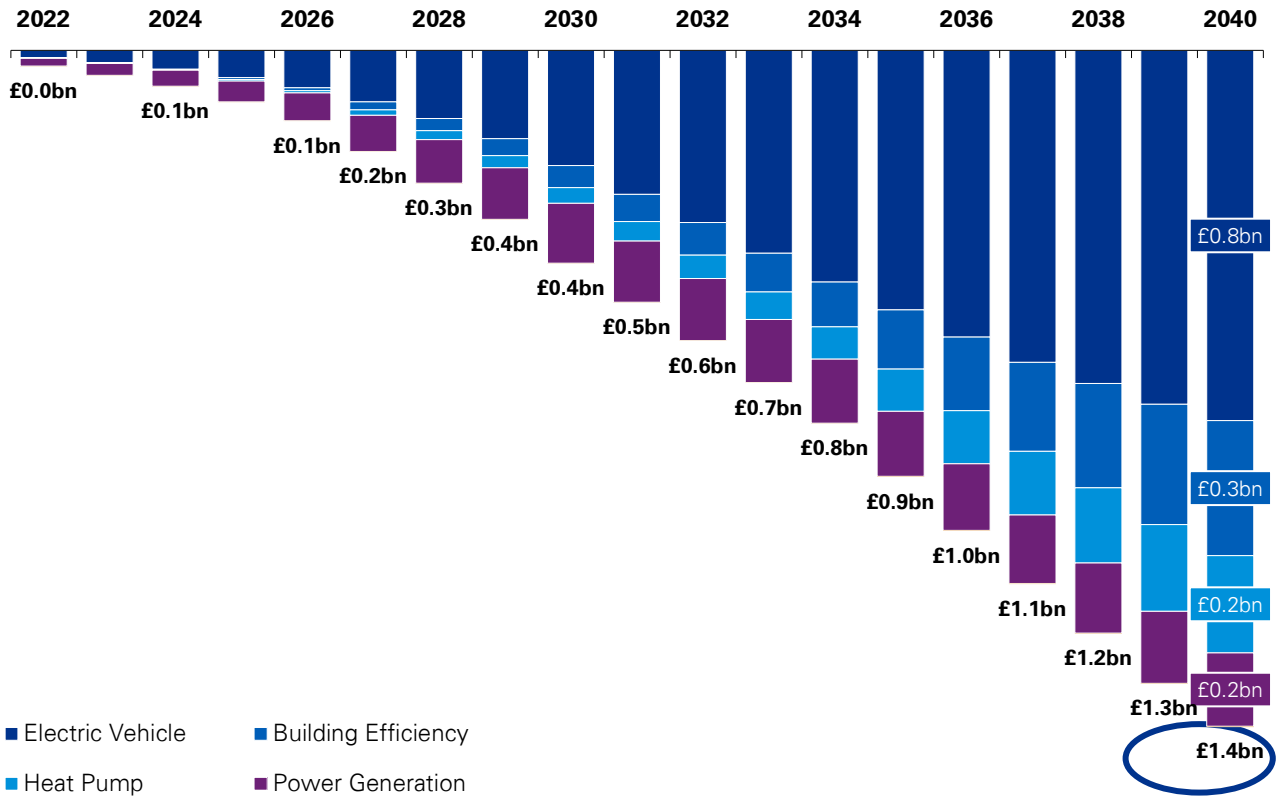
Incremental Investment GVA



Source: NISRA, KPMG Analysis

Impact on Fossil Fuel Spending

Avoided Annual Fossil Fuel Spend by Category (£bn)



Source: KPMG Analysis

Reduction in Fossil Fuel Spend

- The aggregate impact of the £9.6bn capital spending programme required to deliver electrification is an annual reduction in fossil fuel spending of £1.4bn. In each case imported fuels are displaced by energy sourced from indigenous renewable sources.
- **Transport:** Expensive and highly-refined petroleum-based products are eliminated, delivering benefits of £0.8bn.
- **Building efficiency and heat pumps:** c.60% of NI's houses are heated with oil. Heat pumps are primarily expected to displace oil boilers with some displacement of solid fuel also occurring (<5%).
- **Power Generation:** The majority of fossil fuel savings from power generation comes in the period 2022-2028. Post-2030 growth in renewable energy generation supports increased demands from other sectors.

05

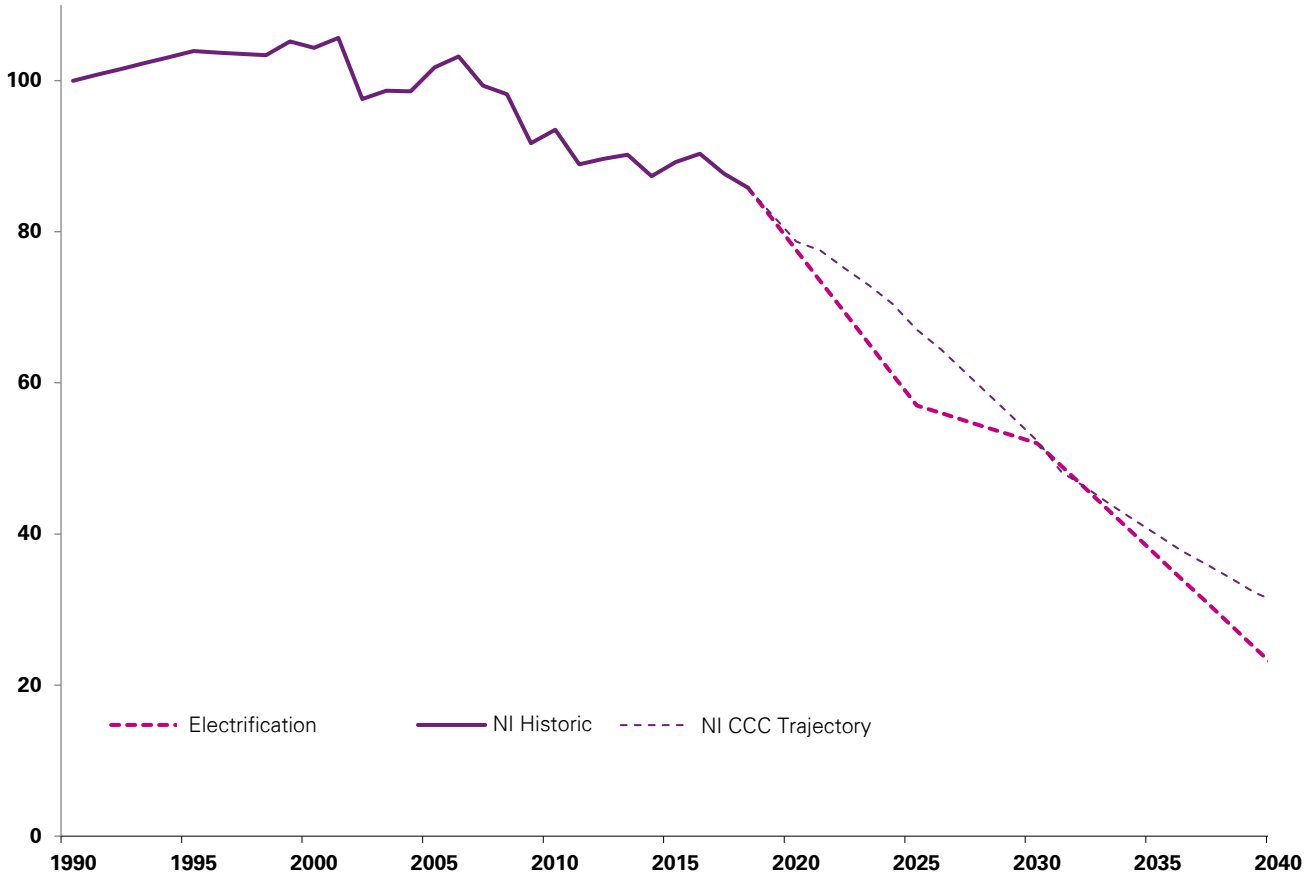
Environmental Impact

Electrification and NI GHG Emissions

Impact on GHG Emissions

- The impact of Electrification on NI's GHG emissions trajectory is shown in the figure on the right; the reduction is fully aligned with an 82% reduction in GHG emissions (as per CCC recommendation).
- The rapid deployment of renewable generation in the period to 2030 coupled with a strong ramp up in EV and heat pumps in the period 2030-2040 deliver an overall reduction in emissions that brings NI much closer to the overall UK trajectory.

GHG Emissions (1990=100)



Source: CCC, NIE Networks

Impact on Air Pollution

Positive Environmental Externalities

Achieving a reduction in climate-warming GHGs is the primary objective of Net Zero, however Electrification of the NI economy also has the potential to create other positive externalities for the environment. This is because combustion of fossil fuels to power heating and transport also gives rise to other emissions that have a deleterious impact on the environment and public health.

Poor air quality in NI has been associated with considerable negative effects on health – each year an estimated 800 deaths are attributable to air pollution[1], particularly in urban areas.

Nitrogen Oxides

- Nitrogen oxides are a group of gases which are the product of atmospheric combustion – primarily in the transport sector. Nitrogen oxide emissions from transport (frequently occurring in conjunction with PM2.5) are correlated with increased mortality.

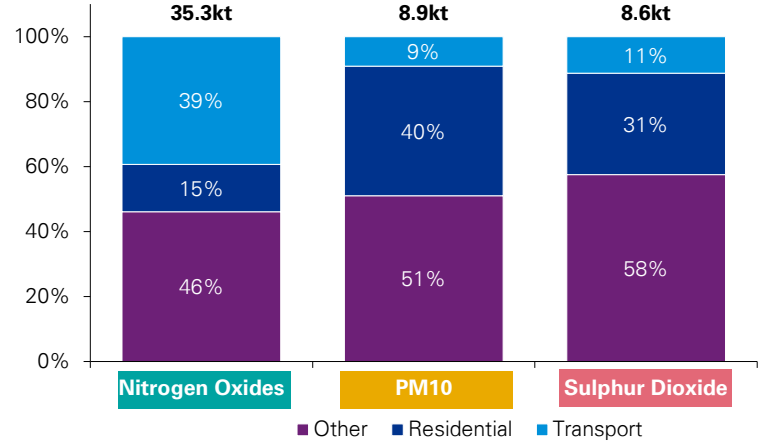
PM_{10}

- PM_{10} describes inhalable particles, with diameters that are 10 micrometres and smaller. There is a well-established relationship between increased risk of death and higher PM_{10} concentrations. The largest single source of PM_{10} in Northern Ireland is residential heating – with coal and wood combustion being 2-orders of magnitude more polluting that gas or oil on a per kWh basis.

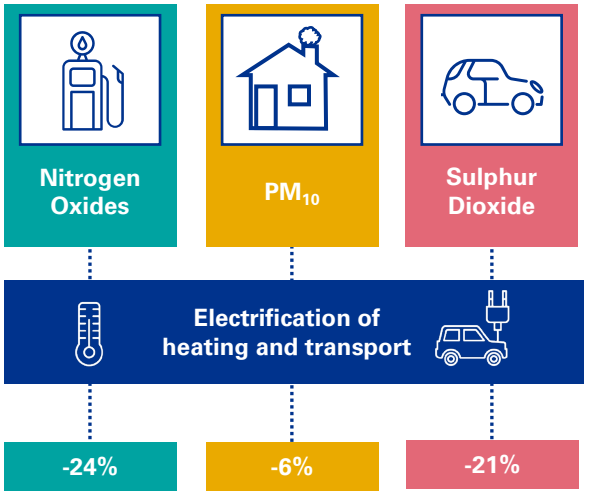
Sulphur Dioxide

- Coal's diminishing role in power generation has contributed to a significant reduction in sulphur dioxide in recent years, however sulphur dioxide continues to be a major cause of acidification which is particularly damaging to native ecosystems. Sulphur dioxide has been shown to be a significant contributor to cardiac and respiratory-related mortality.

Key NI Emission Sources (2018)



Source: DAERA



Electrification leads to a significant reduction in each of the major emissions categories considered.

Source: KPMG Analysis

(1) British Heart Foundation

06

Potential to Accelerate Innovation

Electrification: Strong Alignment with NI Economic Strategy

DfE have outlined a vision for NI's economic development in a strategy document titled '*10X Economy - an economic vision for a decade of innovation*'. Electrification of key sectors in NI is very much aligned with this vision.

A Greener, More Sustainable Economy

- A highly-decarbonised and electrified economy will be increasingly important to maintain the strength of NI's offering to the best companies and most talented individuals considering relocation.
- Reducing emissions will not only create an economy that is consistent with an increasing number of environmentally conscious companies and individuals, it will also improve the regional environment leading to improved health outcomes.

Broad Range of Employment Opportunities

- Electrification of the economy is concomitant with a major capital investment program that will require a range of skills including construction, finance and project management.
- A major efficiency program will create a demand for skilled (electrical, plumbing, carpentry and other building) and semi-skilled labour, which means that the roles created will not be limited only to those with a university education.

Innovation Opportunities

- Implementation of high levels of Electrification requires a change in the way that the power system is operated; this change creates opportunities for energy market participants to utilise smart meter data to develop and commercialise innovative new services and business models.
- Moving quickly and at scale to introduce very high levels of renewable penetration while electrifying heating and transport, has the potential to attract new players to the sector as well as incumbents.
- If NI moves ahead of other regions that will ultimately need to solve the same issues there is a natural opportunity for locally-developed technology solutions and a local supply chain to emerge which ultimately creates export opportunities.

Developing Renewable Energy Production Cluster aligns with the Vision and the Focus of Northern Ireland's 10X Economy Strategy:

- Focusing on technological development and Climate Change; and
- Supporting Northern Ireland's decade of innovation, that will encourage greater collaboration and innovation;
- To support the whole economy and provide opportunities for all of Northern Ireland.

10X Economy Outcomes
✓ Better opportunities for young people
✓ More businesses growing and expanding
✓ All people, benefitting from improved economc prosperity
✓ A better overall quality of life
✓ Increased wellbeing
✓ A greener, more sustainable economy
✓ Increased wages
✓ More entrepreneurs taking a chance and starting a business
✓ Opportunities to reskill and upskill
✓ More and better job opportunities for all
✓ More people entering the labour market

Catalyst for a Zero Carbon Energy System Cluster

The emergence of regional industrial clusters is a topic of considerable research in the field of economic development. Some of the best known examples are the information technology sector in Silicon Valley, motorsports in the South of England and food equipment manufacturing in Northern Italy.

While it is difficult to draw a direct correlation between a regional cluster and a single set of actions, KPMG have identified frequently-observed characteristics and mapped this to the opportunity provided by Electrification.

Existing Building Blocks

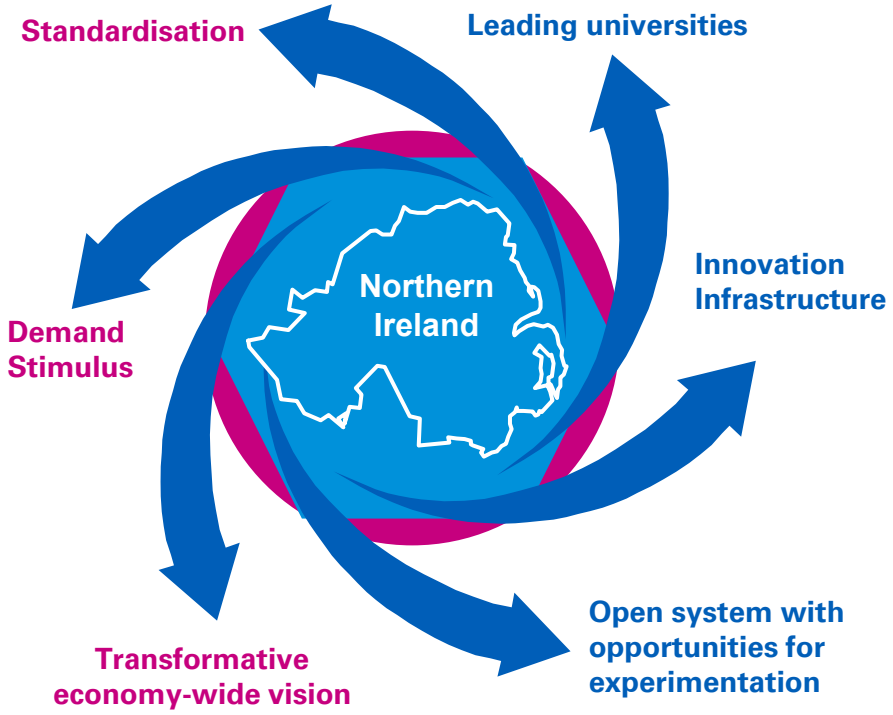
- **Leading Universities & Innovation Infrastructure:** NI boasts two excellent universities – Queens and Ulster – with engineering, science and business education programmes as well as strong research departments. Invest NI and Innovate UK already fund a knowledge transfer partnership programme which provides funding. In addition to finance, there are a number of physical facilities for entrepreneurs including the Innovation Factory and Catalyst.
- **Open system:** NIE Networks is already working with innovative businesses such as Girona Energy to test the operation of smarter solutions to address flexibility challenges.

Required

Electrification presents the opportunity to strengthen the innovation environment even further through:

- **Standardisation:** Clearly defining standards (e.g retrofit standards or flexible control protocols) allows for cost-reduction and interoperability.
- **Demand Stimulus & Transformative Vision:** The contemplated investment has already been shown to be significant in the context of NI's economy. Focussing on deployment of EVs and Heat Pumps creates a critical mass that can draw-in entrepreneurs from adjacent, or even unrelated sectors. Ensuring government commitment to an investment programme of this scale gives a strong signal that there are major economic opportunities in the sector.

Technology and business models to support an integrated energy system



Electrification has the potential to stimulate the emergence of a low carbon energy innovation cluster in NI.

07

Conclusion

Investment Led Growth

Electrification is an ambitious goal that would see £9.6bn invested across the next two decades.

Addresses Key Problem

Electrification would address three major sources of GHG in Northern Ireland.

Immediate Impact

Transformation on this scale would drive change in the economy immediately through employment related to investment and broader economic spillover.

Long-term Benefit

Economy would benefit in the long-term through avoided fossil fuel importation and the potential for a innovation-led growth.

Broader Benefits

Electrification strikes at the source of some of the most harmful emission categories improving health and environmental outcomes.

Clear Impetus for Change

- The rationale for NI to decarbonise its economy is clear: the costs, both direct and indirect from failing to do so will be huge. NI's continued ability to attract and retain leading talent and the best businesses (including indigenous companies) is contingent in many cases upon access to clean energy.
- Combustion of fossil fuels has a negative impact on the health of NI's citizens and Electrification presents an opportunity to significantly reduce air pollution.

Electrification Technologies

- NI lags somewhat behind the rest of the UK – due in large part to the success of its agricultural sector – but Electrification presents an opportunity to decarbonise key non-agricultural sources of GHG emissions.
- The technologies of Electrification are well-understood and can be deployed quickly to significantly reduce emissions.

Major Capital Investment Programme

- The costs of Electrification are expected to be significant (£9.6bn), however the benefits of this investment will start to be realised immediately through a reduction in fossil fuel imports (£1.4bn by 2040) and will continue for the lifetime of these lower running cost technologies.
- This major capital investment is also expected to have positive spillover effects on the economy through increased GVA and employment opportunities for an estimated 5,000 individuals during construction.

Transformative Potential

- Electrification is strongly aligned with DfE's economic vision for NI as an innovation economy delivering employment to individuals with a range of skills and ensuring that gains are not concentrated in small sections of the population.
- Electrification also creates the opportunity to develop a local supply chain and leverage existing local expertise in the areas of cyber security and other engineering services to develop an export-focussed industrial cluster.

08

Appendix

Important Notice

This report has been prepared for and on behalf of NIE Networks.

All work carried out by KMPG was carried out on the instruction of NIE Networks in accordance with the professional services agreement (the "Agreement") dated 13th May 2021.

The report contained herein is primarily based on publicly available information and is only intended to address the requirements of NIE Networks as set out in the Agreement, and not any third party individual or entity.

KPMG accepts no liability or responsibility whatsoever for any loss or damage suffered or costs incurred by any third party individual or entity arising out of or in connection with this report, however the loss or damage is caused. No third party should act on this report without appropriate professional advice after a thorough examination of the particular situation.

Although we endeavour to ensure the accuracy of the contents of this report, the accuracy of the information contained herein is dependent on the accuracy of the publicly available information. We have sense checked the underlying information however we cannot provide any guarantee or warranty as to its accuracy.

The information contained herein is of a general nature and is not intended to address the circumstances of any particular individual or entity. Although we endeavour to provide accurate and timely information, there can be no guarantee that such information is accurate as of the date it is received or that it will continue to be accurate in the future. No one should act on such information without appropriate professional advice after a thorough examination of the particular situation.

kpmg.ie