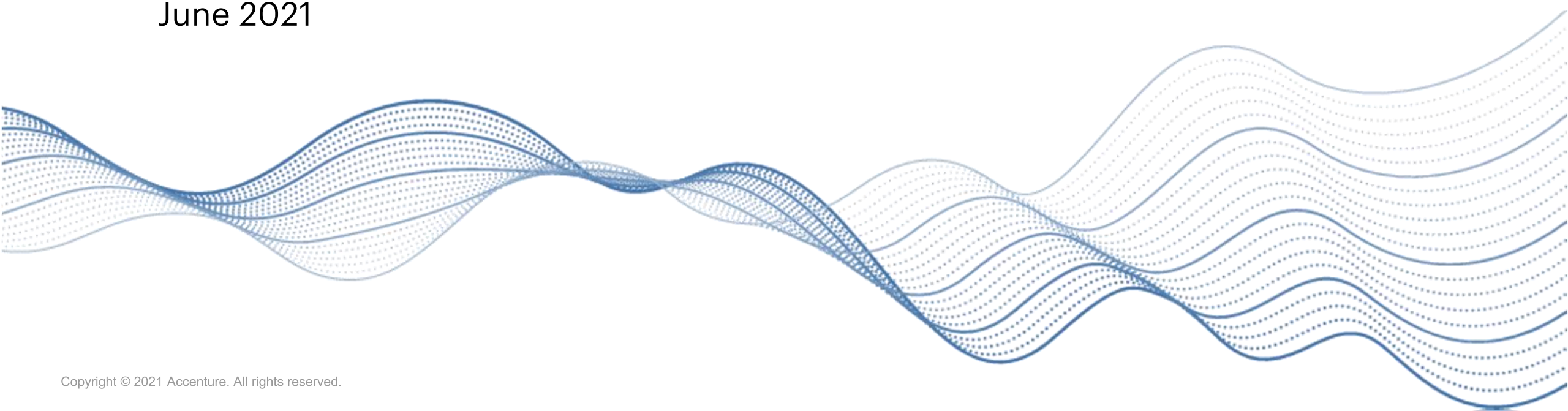
Energy for generations

accenture

System Value Analysis for Northern Ireland's 2030 Climate Targets

June 2021



Northern Ireland's climate commitments

Northern Ireland is developing climate change legislation which is expected to establish emissions reduction targets. In advance of a specific Northern Ireland target being established, this analysis uses the Committee on Climate Change (CCC) 6th Carbon Budget proposed target of a 48% reduction in emissions by 2030 versus 1990[1].

What's being targeted

By 2030

48%
(~5% YOY)
Average decrease in CO2eq emissions over 2021-2030

By 2050

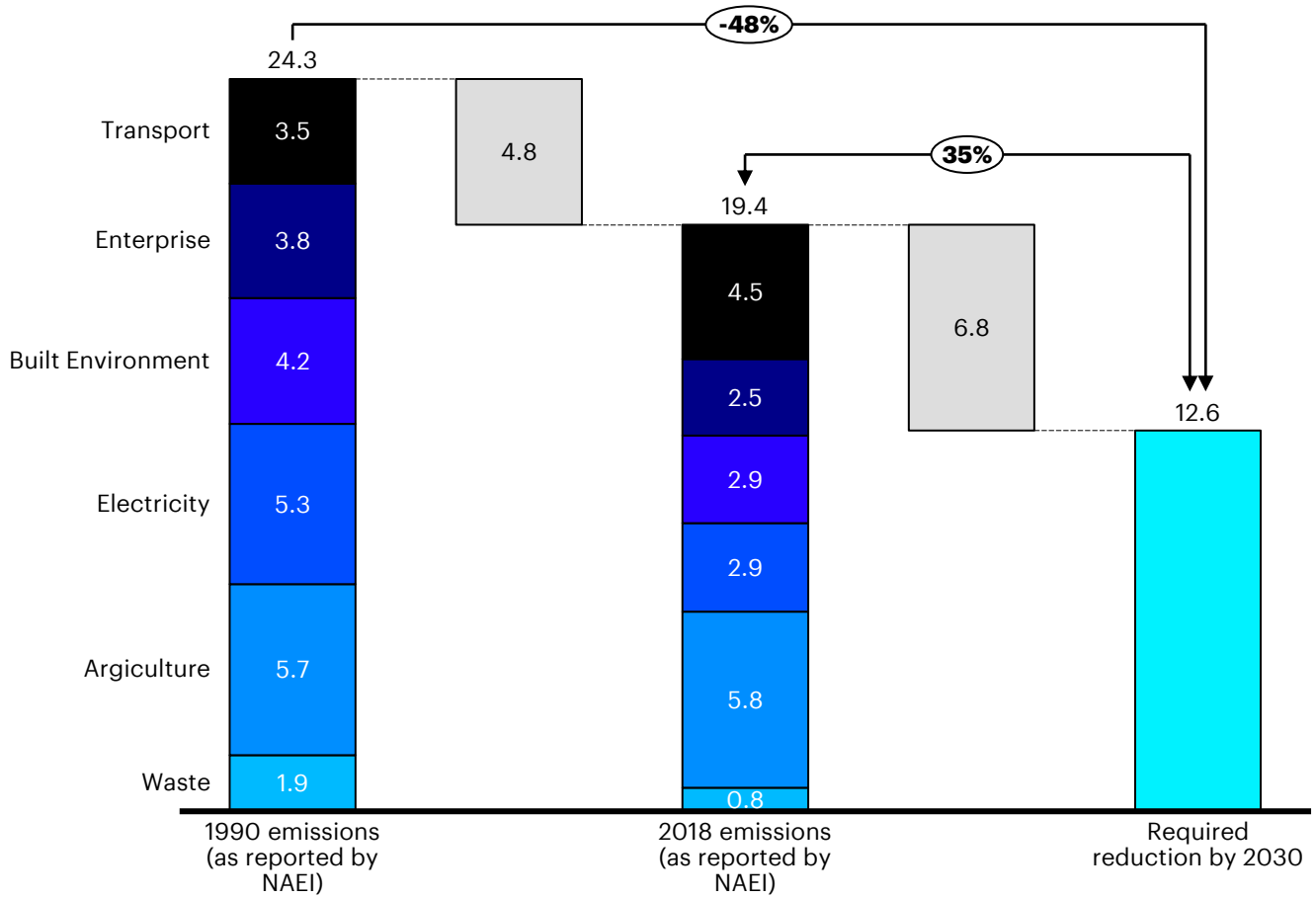
82%
emissions reduction for Northern Ireland as a contribution to the UK's net-zero target

Defining the Ambition

Northern Ireland is currently in the process of developing a Climate Change Bill, due end 2021. This bill will contain the first set of legally binding carbon targets for Northern Ireland. Currently, two bills are in development; one by DAERA, in line with the 6th Carbon Budget's advice[2] and the other, proposed by the Green Party, sets out a net zero target for 2045. The second bill[3] was brought to the assembly 22/04/21. It is not yet clear which piece of legislation will take precedence.

This analysis presents a suite of economy-wide actions for deeper emissions reductions. Overall, a cross-sectoral, multi-stakeholder approach is necessary and swift action will enable maximum impact on the carbon budgets out to 2030.

GHG emission progress towards 2030 Northern Ireland target ($MtCO_{2eq}$)



Note: (1) Greenhouse gas (GHG) emissions are CO_2 equivalent (CO_{2eq}). Mt = million (metric) tonnes. CO_2 as referred to in this report = CO_{2eq}
(2) 2030 emissions are based on the 6th Carbon Budget target applied to the NAEI baseline. There is some inconsistency between the historical emissions recorded by 6th Carbon Budget and NAEI/ BEIS.

Sources: (1) CCC; (2) Energy Strategy; (3) BBC

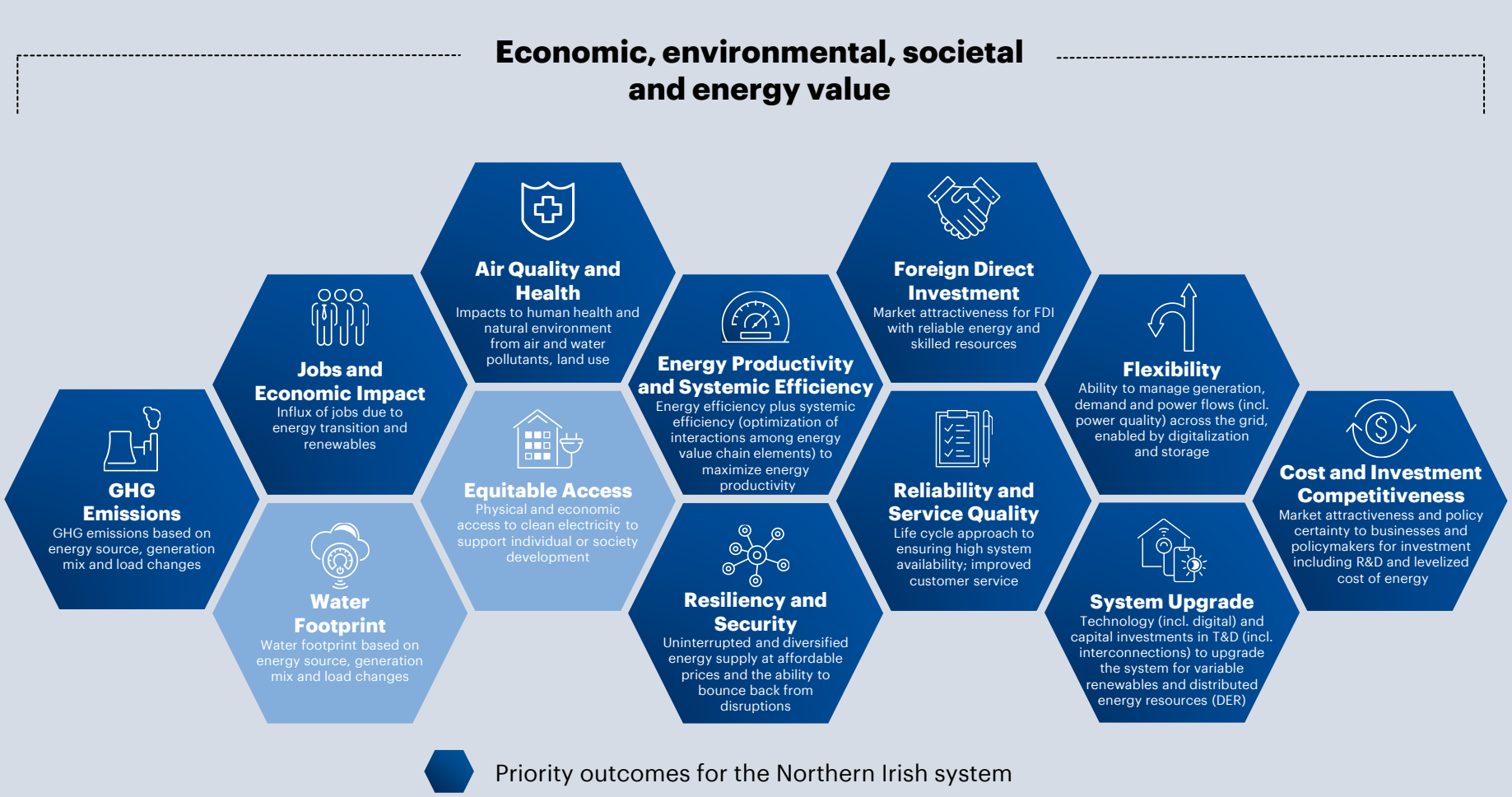
System Value of the clean energy transition in Northern Ireland

The System Value framework more holistically evaluates economic, environmental, social and technical outcomes of potential energy solutions across markets. The framework aims to **shift political and commercial focus beyond cost to include value.**

Each of these key dimensions represent **an outcome that delivers value to society or the energy system** (e.g. jobs & economic impact, system flexibility).

The framework considers both quantitative and qualitative outcomes.

Key dimensions for Northern Ireland have been prioritized based on current market dynamics and relative maturity of transition towards an integrated energy system delivering net-zero GHG emissions.



Note: The Water Footprint and Equitable Access dimensions should be seen in a global context where countries experience water scarcity/ stress issues or do not have nationwide access to electricity. As such, these dimensions were discussed in the India and Brazil reports but not in the Northern Ireland or UK analysis.

Our proposed solutions for Northern Ireland

Solutions to achieve the 6th Carbon Budget ambition

Power System Decarbonisation

Phase out coal and oil and deploy additional 1271 MW of onshore wind and 500 MW of offshore wind by 2030. Interconnection will continue to play an important role with storage solutions to increase security and flexibility.

~1.5 Mt CO_2 reduction in energy industries in 2030

15k-23k Jobs from onshore and offshore wind expansion by 2030

£30-45mn Human health benefits in 2030

Decarbonisation of Light Duty Transport

Accelerate EV deployment by accelerating timing of petrol and diesel passenger vehicle ban to 2030. Reduce car miles travelled by transport mode shifting and behaviour change (e.g. cycling, bus).

~1.4 Mt CO_2 reduction from EVs & PHEVs in 2030

300-800 Economy-wide jobs in 2030

£85-127mn Human health benefits in 2030

Decarbonisation of Heavy Duty Transport

Eliminate emissions from 50% of heavy goods vehicles and 80% of buses by 2030, substituting diesel with HVO blending, hydrogen, electric or bio-CNG.

~0.4 Mt CO_2 reduction from HGVs and Buses in 2030

1k-4k Economy-wide jobs by 2030

£4-6mn Human health benefits in 2030

Decarbonisation of Housing

Build all new houses to an A rating, retrofit 42% of all C-G rated domestic buildings to a minimum B rating. Deploy 118k heat pumps to new builds and retrofitted houses off the gas grid, thereby replacing all coal and some oil boilers in retrofits.

~1.2 Mt CO_2 reduction from retrofitting & heat pumps in 2030

84k-112k Economy-wide jobs in 2030

£49-74mn Human health benefits in 2030

Decarbonisation of Industry

Improve process and energy efficiency across cement, glass and manufacturing industries. Electrify 65% of the food, paper and transport equipment manufacturing industries. Reduce F-Gases in line with UK & EU legislation.

~1.1 Mt CO_2 reduction from efficiencies in 2030

£13-19mn Human health benefits in 2030

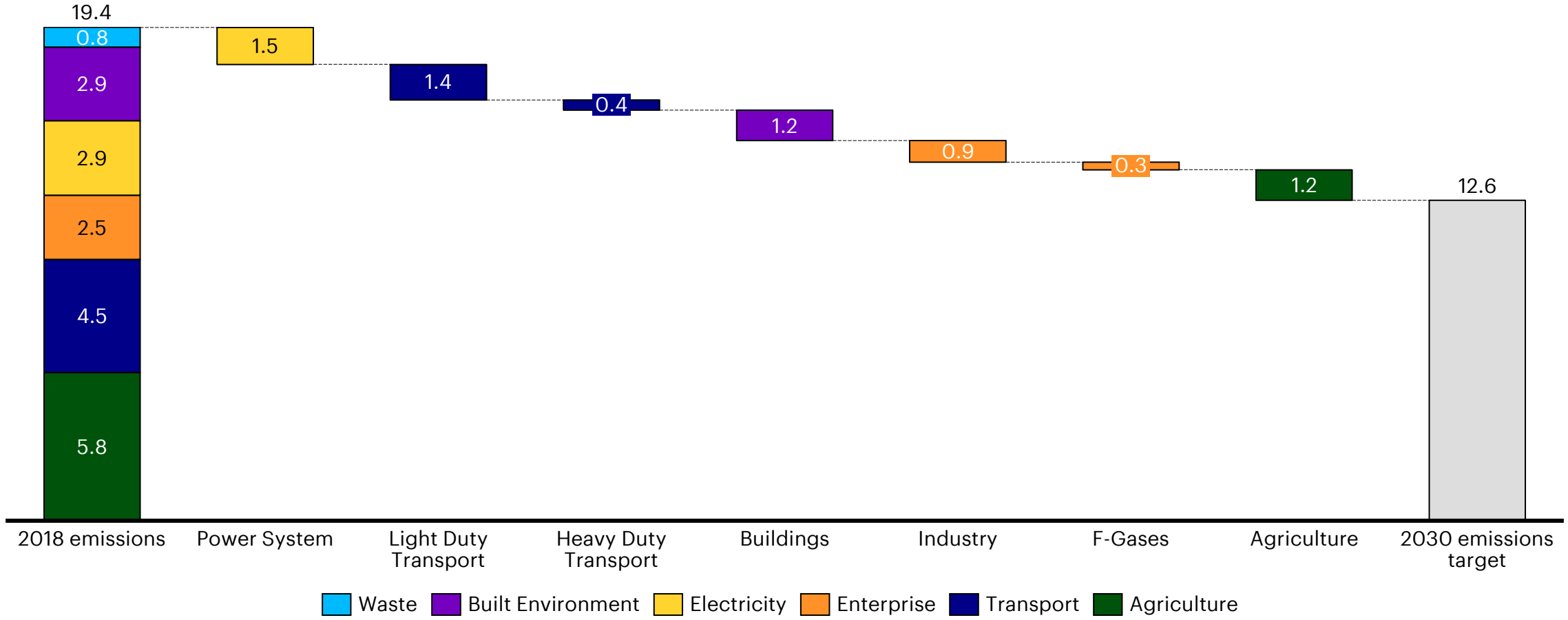
Decarbonisation of Agriculture

Reduce emissions by adopting best practice in selective breeding and the use of feed additives. Electrify fuel combustion applications. Expand biogas production using anaerobic digestors. Optimize soil pH of the grasslands to reduce fertiliser usage, improve crop yields and carbon sequestration.

~1.2 Mt CO_2 reduction from best practices in 2030

Closing the gap: 2018 to 6th Carbon Budget 2030 targets

To meet the 6th Carbon Budget 2030 ambition of -48% on 1990 GHG emissions, Northern Ireland will need to reduce emissions by 35% vs 2018 levels. The solutions below are ambitious but practical ways to drive further reductions, however, greater savings could be realised with a more aggressive approach.



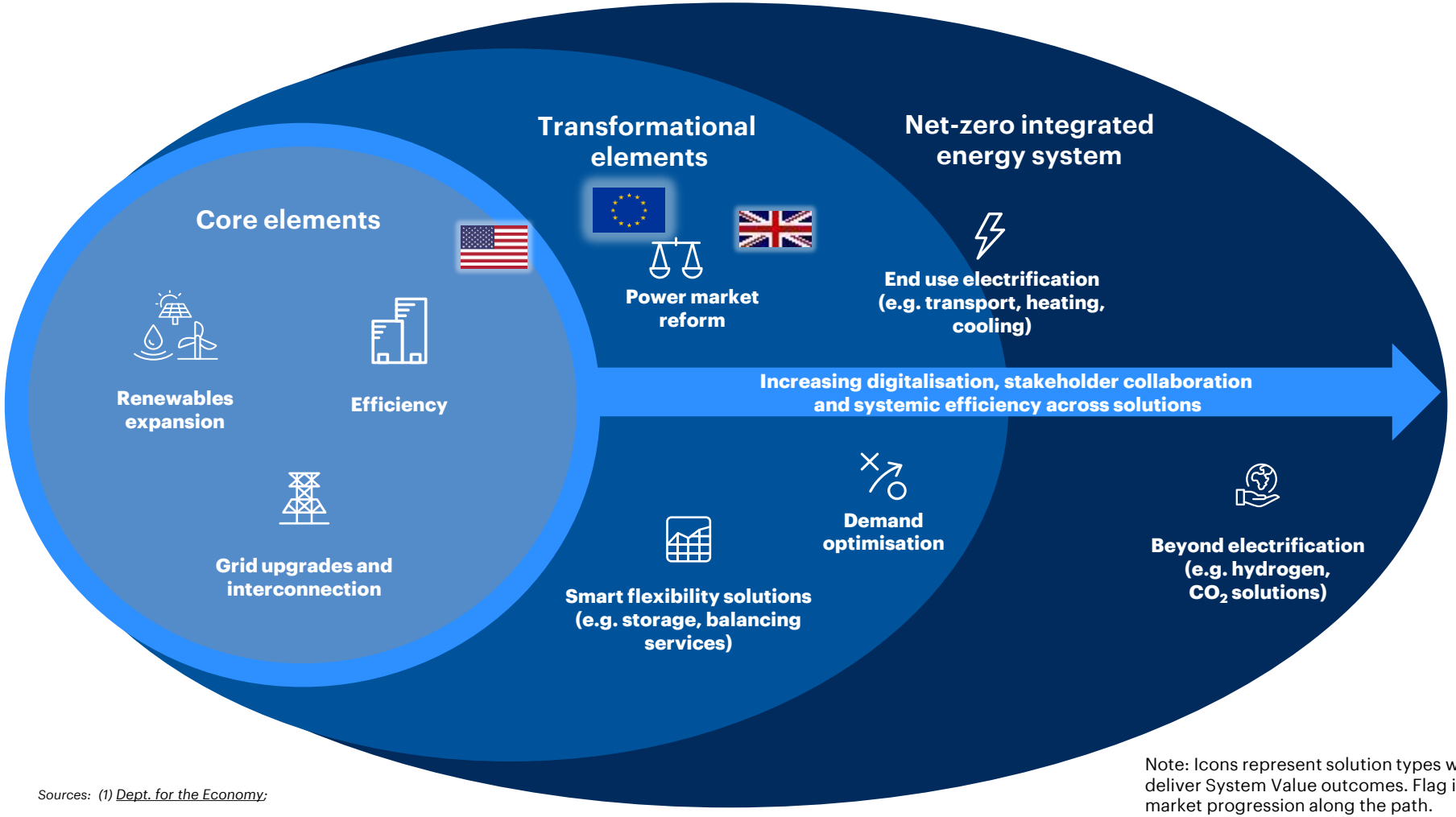
Note: (1) Emissions reductions of proposed solutions are reductions in 2030 – their impact on the carbon budgets between 2021 and 2030 depend on speed of implementation
(2) Greenhouse gas (GHG) emissions are in CO_2 equivalent (CO_{2eq}). Mt = million (metric) tonnes
(3) Numbers have been rounded

Northern Ireland's path to maximise System Value

Markets are moving from addressing core elements of the electricity sector transition...

...through "pivot points" where generation mix hits 20%-30% annual variable renewables (>50% instantaneous) and transformational elements enable...

... acceleration to a net-zero integrated energy system with a strong focus on systemic efficiency



Northern Ireland is at the pivot point, with 49% of consumed electricity generated from renewable sources in 2020, of which 88% was variable (85% wind and 3% solar[1]).

Improving interconnections, transforming power market and networks, electrifying carbon-intensive sectors, and increasing storage solutions will have increased importance through the 2030s and beyond.

Note: Icons represent solution types which deliver System Value outcomes. Flag indicates market progression along the path.

Sources: (1) Dept. for the Economy;

Potential solutions for Northern Ireland

01 Power System Decarbonisation

02 Decarbonisation of Light Duty Vehicles

03 Decarbonisation of Heavy Duty Transport

04 Decarbonisation of Housing

05 Decarbonisation of Industry

06 Decarbonisation of Agriculture

1. Power System Decarbonisation

Overview

Northern Ireland is a leader in renewables, meeting 49.2%[1] of electricity consumption from RES-E in 2020. Emissions from fossil fuel electricity generation are expected to drop to 1.5 $MtCO_2$ per annum per SONI's Tomorrow's Energy Scenario 2020[2] report (TES).

Renewables expansion to phase out oil & coal

- Coal and oil accounted for 50% of emissions while making up only 15% of generation in 2018[3]. Phasing out coal and oil will **save ~1.5 $MtCO_2$** per annum. To replace coal and oil, renewables will be expanded.
- Under SONI's most ambitious 'Accelerated Ambition' scenario, 80% of electricity will come from renewable sources in Northern Ireland by 2030. To achieve this, an additional 1271 MW onshore wind and 500 MW offshore wind will be built by 2030[2].
- Using SONI's high range AA scenario puts NI on the path to a fully decarbonised power system by 2040[2] and would create ~7k more jobs than the mid range scenario. It also allows higher electricity demand for 2030 as is required for our proposed solutions.

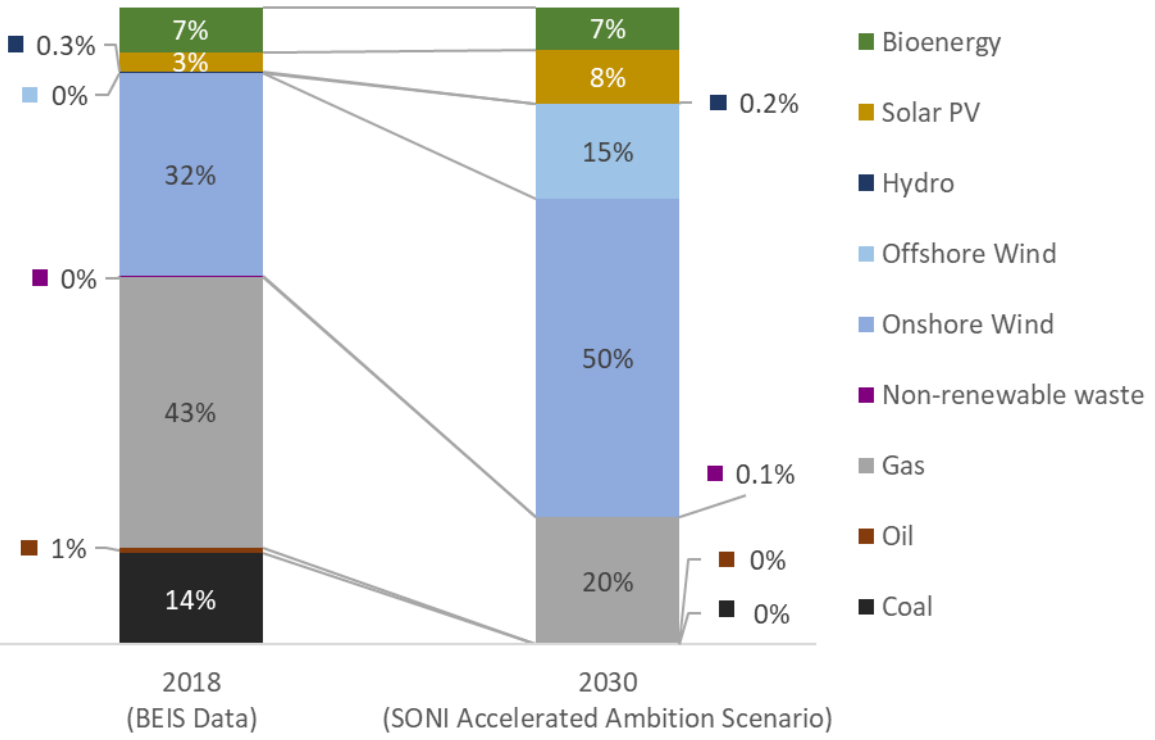
Interconnection

- Interconnection will remain important in Northern Ireland, with Scotland providing clean energy through the Moyle Interconnector. Scotland has ambitious wind targets and aims to be a net exporter of renewables by 2032[4], increasing offshore wind capacity from 1 GW today to 11GW by 2030[5]. In 2018 Northern Ireland was a net importer of 706GWh[3] from Scotland, equivalent to ~180MW of offshore wind.
- The planned North-South Interconnector will improve the efficiency of the SEM, reduce some operational constraint limits and help to reduce curtailment. It will also provide security of supply and best value for consumers[2].

Storage and flexibility

- A recent NI study by NIE & QUB demonstrated how battery storage can facilitate increased adoption of low carbon technologies, minimize curtailment of renewables and ensure that the network continues to operate within safe and permissible limits. The study also showed storage devices can be used to provide ancillary services in the network, e.g. load levelling, enhancing network security and stability[6].
- A high level of renewables penetration and reduced reliance on natural gas will need to be underpinned by sweeping reform in system operations and power markets to increase flexibility through measures such as SONI's DS3+ programme.

Percentage Electricity Generation by Fuel in 2018 and 2030



System Value Impacts of Power System Decarbonisation

1.5 Mt
CO_2 reduction in energy industries in 2030

15k-23k
Jobs from onshore and offshore wind expansion by 2030

£30-45mn
Human health benefits in 2030

Sources: (1) Dept. for the Economy; (2) TESNI 20; (3) BEIS: Imports, exports & transfers of electricity; (4) Scottish Government 2018-2032; (5) Scottish Government; (6) NIE Networks for Net Zero;

2. Electrification of Light Duty Vehicles

Overview

The UK has committed to accelerating EV adoption by bringing forward the ban on the sale of new internal combustion engine (ICE) passenger vehicles to 2030 from 2035[1]. In 2018, 3.2 $MtCO_2$ of transport emissions were attributed to cars and vans (72% of transport emissions)[2]. EVs are a low regret option to reduce emissions with Bloomberg predicting EVs will be cheaper than ICE cars & vans in all segments by 2027[3].

Reduction in car miles

- Northern Ireland has a highly car dependent society. Of journeys of one mile or over, 87% are made in a car, with 59% of people driving to work for a journey less than 2km[4]. Savings of **0.3 $MtCO_2$** can be achieved if people switched 10% of car miles to journeys on foot, by bike or public transport.
- The long term impact of COVID on travel is not yet known but with only 5% of Belfast office based workers returned to their workplaces full-time in September 2020[5], academics predict a "likely drop in traffic levels" due to increased remote working[6]. Schemes such as charging for road usage and car parking, car sharing schemes and investing in cycle routes, parking and rental would also contribute to a reduction in car travel[4].

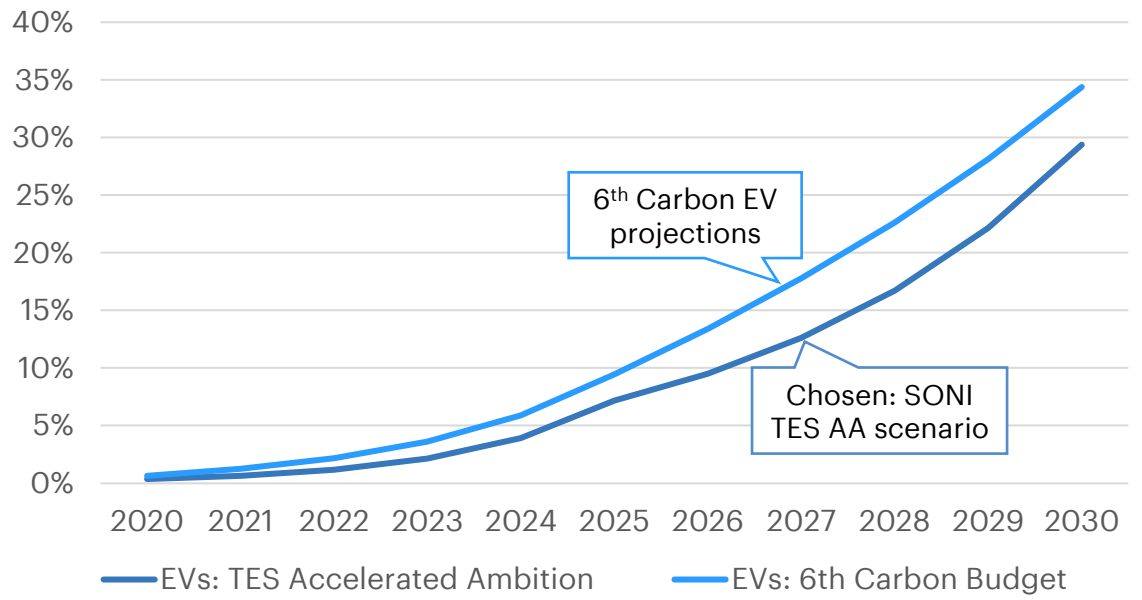
EV adoption

- The current car and van stock in NI is estimated to emit an average of 193gCO_2/km and 305gCO_2/km[7], respectively. Emissions from the electricity generated to power EVs are accounted for in the power system emissions, therefore a switch to an EV will save the maximum gCO_2/km in transport.
- SONI's Accelerated Ambition scenario models an end of ICE sales by 2030. Adopting this means 372k EVs will be on the road by 2030, accounting for almost 30% of cars & vans. Assuming 25% of these sales are for vans, this will result in a reduction of **1 $MtCO_2$**.
- Investment in charging infrastructure is required to cater for the increase in EVs. Currently there are only 337 public charging points installed in NI. This number must expand to between 30 and 35 public rapid chargers on major roads and 800 to 950 public top-up chargers[8].

Fuel efficiency

- The current car stock in NI is estimated to emit an average of 193 gCO_2/km[7], with new cars in 2019 emitting only 122 gCO_2/km[9], on average. Some of cars bought between now and 2030 will still be ICE cars, but further fuel efficiency standards and taxes on fuel inefficient cars can lead to emission savings. However, introducing taxes on high emission ICE vehicles may be unpopular politically.
- 158k ICE vehicles are replaced by newer ones by 2030, giving a total saving of **0.2 $MtCO_2$**.

Cumulative EV uptake in Northern Ireland by 2030 (passenger vehicles)



System Value impacts of electrification of passenger vehicles

↓ 1.4 Mt*

Reduction of CO_2 emissions from passenger EVs in 2030 in base case (TES AA) plus an additional 0.2 Mt with 63k extra EVs (6th Carbon)

↑ 300-800**

Additional economy-wide jobs in 2030 from incremental EV deployment in accelerated case

↑ £85-127mn

Human health benefits through 2030 due to decreased air pollution (NO_x, PM) from EV adoption

Sources: (1) BBC; (2) NAEI; (3) Bloomberg BNEF; (4) NI Assembly; (5) BBC; (6) BBC; (7) DAERA, table 5.2; (8) NIE; (9) EEA

** Differences due to rounding*
***300 jobs will be created if there is no domestic battery production in NI, and 800 if batteries are manufactured in NI.*

3. Decarbonisation of Heavy Duty Transport

Overview

HGVs and public passenger transport (buses) accounted for 16% of transport emissions in 2018, generating 0.7 $MtCO_2$[1]. The 6th Carbon Budget targets equate to a 0.3 $MtCO_2$ reduction in emissions.

Zero or low emission HGVs and buses

- Translink will add 100 zero carbon (80 electric & 20 hydrogen) and 45 low carbon buses to its fleet by 2022, with the aim of operating a zero-emission fleet by 2040[2]. Options to increase penetration of zero or low emissions HGVs and buses include:
- Electric - suitable for inter and intra city travel:
  - The longest bus route in Belfast is around 26 km[3], and London electric bus (330 kWh engine) has a range of ~240 km[4]. Translink will add 80 electric buses by 2022. Electric buses will also provide an option for vehicle to grid flexibility[5].
  - Commercial vehicle manufacturer, such as Volvo and Traton, aim for 50% of their European truck sales to be of electric trucks by 2030[6].
- Hydrogen - suitable for long range buses and trucks:
  - Hydrogen trucks can drive as far as 1,200 km on a full tank[7], four times the length of Northern Ireland and equal in range to most diesel trucks.
  - Three hydrogen buses are currently in service in Belfast. This hydrogen is produced locally using green electricity from an onshore wind farm in Antrim[8].
  - These buses use a purpose built hydrogen refuelling station in Belfast where the hydrogen is delivered to[9]. This station is the first of its kind in Northern Ireland.
- Bioenergy - suitable for mid-long range:
  - Bio-CNG trucks typically have a range of up to 800km[10].

Rail freight development

- An all-island Strategic Rail Review is being launched, and it will consider the feasibility of "high - / higher speed rail" on the network and whether there is a potential to increase use of the network for freight[11].

Recommendation

- The 6th Carbon Budget suggests actions to implement all the options listed above. We propose increasing the ambition to eliminate emissions from 50% of HGVs and 80% of buses resulting in a total **reduction of 0.4 $MtCO_2$** in 2030. We recommend a technology-agnostic mix of the solutions listed above to achieve this reduction, allowing market forces to decide the ultimate split.

The Hydrogen Fuel Cell Bus in Belfast

System Value Impacts of Zero or Low Emissions HGVs & Buses

↓ ~0.4 Mt
CO_2 reduction from buses and HGVs in 2030

↑ 1k-4k*
Economy-wide jobs by 2030

↑ £4-6mn
Human health benefits in 2030

*The range of jobs created depends on how much of the fleet is going to be electric, using biogas or hydrogen.

Sources: (1) NAEI; (2) Translink ; (3) Translink; (4) Alexander Dennis; (5) SSE; (6) Financial Times; (7) Agility fuels; (8) Irish Times; (9) Network; (10) Sustainability Journal; (11) Dept for Infrastructure

4. Decarbonisation of Housing

Overview

With 67% of houses below an EPC C rating[1], Northern Ireland has one of the most energy inefficient building stocks in Europe and needs to improve building efficiency to achieve its 2030 and 2050 climate targets. Emissions are also high due to 68% of residential buildings being heated by oil and only 24% connected to the gas grid by 2016[2].

Considering that 22% of households[3] (~405k people) in Northern Ireland are in energy poverty, a key goal of this report is to develop solutions that would reduce energy bills.

The CCC identified 5 low regret routes to reduce emissions from heating buildings: retrofit existing buildings, high standards for new builds, heat pumps for homes off the gas grid, district heating, and biomethane/ hydrogen for homes on the gas grid[4]. These recommendations formed the basis of our approach.

Impact of new houses

- Taking the average of the last 10 years[5], 68k new houses will be built by 2030. If these houses are A-D rated, emissions will be **0.19 $MtCO_2$ higher** than in 2018.
- If all new houses have an A rating, that can **save 0.13 $MtCO_2$**. It is assumed that 80% of new houses (54k in total) will require heat pumps to help reach the A rating.

Retrofitting buildings to a B rating and deployment of heat pumps

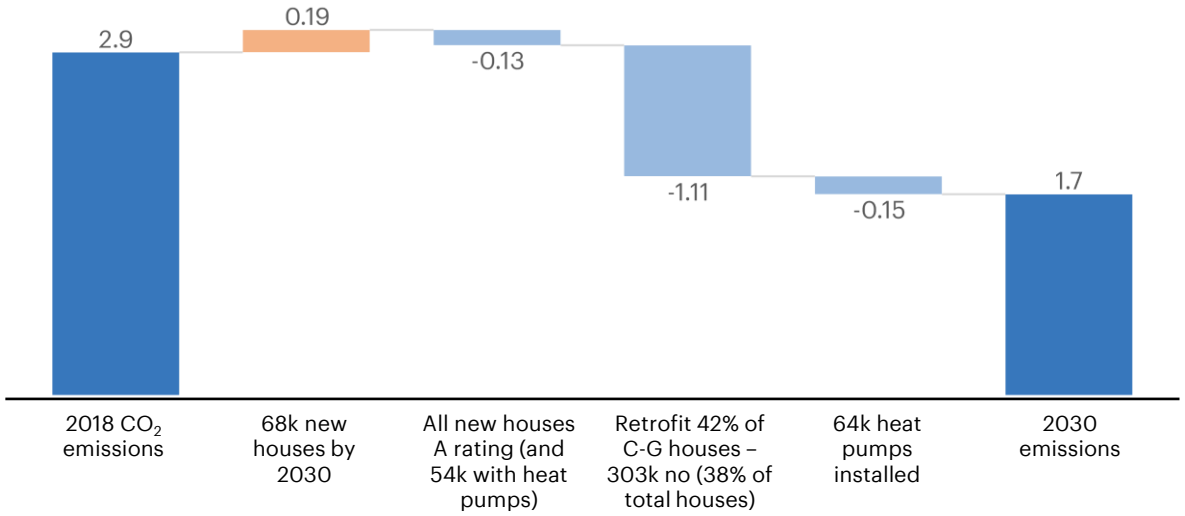
- Retrofitting fewer houses to a B standard rather than a greater number to a C was the selected approach as although more expensive (£6 billion vs £3.1 billion), it allows more energy savings, creates more jobs, more health benefits, and is future-proofed.
- Upgrading C-G houses to a B rating costs an average of £15,600/ house[6]. If 303k C – G houses were retrofitted to B by 2030 (42% of C-G houses), this would **save 1.11 $MtCO_2$**.
- 64k heat pumps need to be deployed in houses off the gas grid that are undergoing retrofits to reach the B rating. Heat pumps in retrofitted houses will reduce emissions by **0.15$MtCO_2$**.
- Currently, there are ~16.5k retrofits or boiler replacements per year[9].
- The government provides grants up to £7,500 to add insulation and/or replace a 15+ year old boiler, targeted at lower income households[7]. Current heat pump grants only cover a proportion costs (up to a maximum of £3,500)[8].

Important considerations

- District heating and the injection of hydrogen or biomethane into the gas grid could provide even greater emissions savings in the future.

Projected emissions reduction pathway in Housing

Retrofit 42% of C-G houses and install 64k heat pumps in existing houses



System Value Impacts of upgrading housing

1.2 Mt
CO_2 reduction from retrofits & heat pumps in 2030

84k-112k*
Economy-wide jobs by 2030

£49-74mn
Human health benefits in 2030

£212mn/ year**
Household savings on energy bills

**In the renovation sector, it is estimated that 33% are direct jobs, 52% indirect and 15% induced, BPIE.*
*** Annual expected savings by 2030, given household energy savings per annum are £700 when retrofitting to EPC B per (6).*

Note: Per the 6th Carbon Budget, 258k heat pump installations are estimated by 2030, 100k more than SONI's high range scenario in TES. For heat pumps to be efficient, they need to be installed in houses above a C rating. As there are only ~270k houses above a C rating in NI currently, we prioritised retrofitting over heat pump deployment.

Sources: (1) NIE; (2) NI Housing Statistics; (3) Public Health Agency; (4) CCC; (5) Department of Finance; (6) Cost of Carbon Savings Report; (7) Turkington; (8) Heat Pumps NI; (9) NIE, p24;

5. Decarbonisation of Industry

Overview

The majority of industry in Northern Ireland is light industry, with a large vehicle manufacturing base. Cement, glass and chemicals are notable exceptions. A combination of solutions have the potential to reduce industrial GHG emissions in Northern Ireland, with Hydrogen and CCS solutions most likely to emerge post 2030.

Industrial efficiency

- Systemic efficiency and circularity is the most underutilised lever in the carbon abatement of industry.
- Applying the 'ambitious but reasonable' scenario for process & energy efficiency improvements from BEIS's Carbon Calculator[1] to Northern Ireland resulted in a **~0.6 $MtCO_2$ saving** across cement, glass and manufacturing industries.

Electrification of industry

- Due to the nature of industry in Northern Ireland, a number of sectors can be electrified to reduce reliance on coal/ oil and other fossil fuels.
- Food, paper and transport equipment manufacturing are all industries that can be close to 100% electrified with current technologies[2]. If 65% of these industries can be electrified by 2030 in Northern Ireland, this would result in a **~0.3 $MtCO_2$ saving**. If electrification was increased to 75% then an additional 0.2 $MtCO_2$ would be saved.

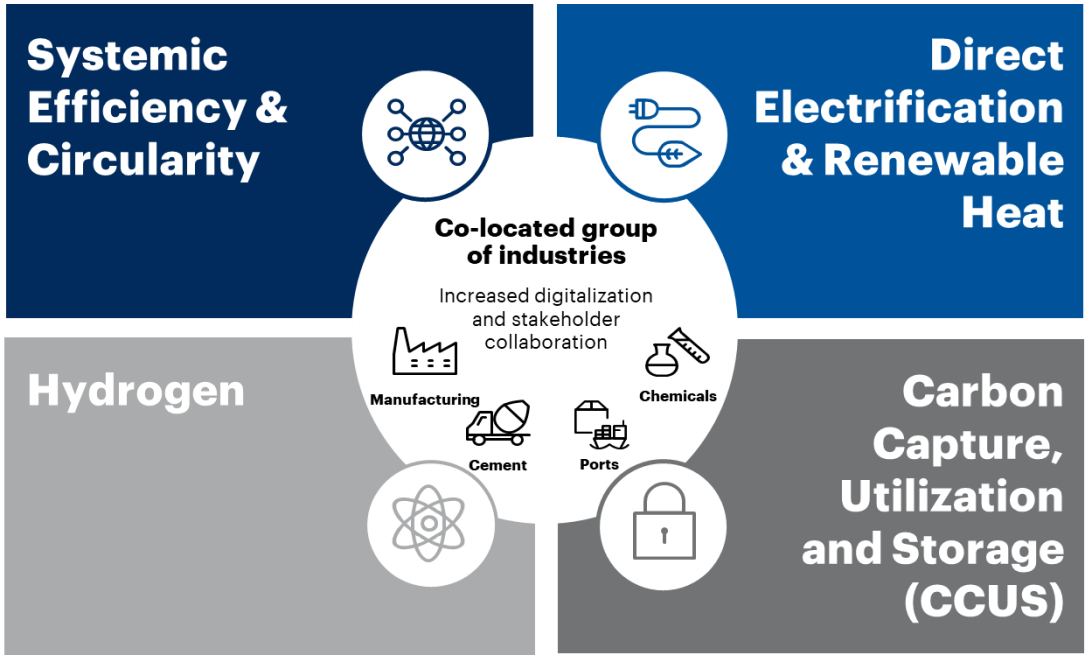
Reduction of F-Gases

- F-gases are powerful greenhouse gases used in a range of industrial applications[3].
- Northern Ireland falls under EU regulation for F-gases post Brexit, as such has a target to reduce F-gas emissions 67% by 2030 (from a 2014 baseline)[4]. If this target is met, a **0.3 $MtCO_2$ reduction** would be realised. This target and the backing legislation is similar to the UK's commitment under the UN Kigali Amendment[5].
- Import, export and production quotas, and service bans are in place across the UK and EU to reduce F-gas emissions. Including legislation on leak detection, certifications to work with F-gases, and a ban on non-refillable containers[6]. To date these policies have been successful, and further regulation is due in 2021 to ensure 2030 targets are met[7].

Additional measure: biomass for glass

- If further reductions are required, Encirc, a large glass manufacturer have recently shown that using biogas and recycled glass in production reduces emissions by 90% vs fossil fuels[8]. If implemented plant wide, this would result in a ~0.2 $MtCO_2$ reduction by switching to biofuel.

Solutions to decarbonise industry



System Value Impacts of Industry Decarbonisation

↓ Up to 1.1 Mt*

CO_2 reduction from efficiency savings, electrification & F-Gas reduction in 2030

↑ £13-19mn

Human health benefits in 2030 due to industrial efficiency and electrification of industry

** Differences due to rounding*

Sources: (1) BEIS; (2) Potsdam; (3) European Commission; (4) UK Parliament; (5) CCC; (6) EFCTC; (7) European Commission; (8) Encirc

6A. Decarbonisation of Agriculture

Overview

The agricultural sector is a key contributor to emissions in Northern Ireland, accounting for 27% of total GHG emissions in 2018[1]. This is high compared to the UK average of 10%, but lower than the Republic of Ireland at 33%.[2]

Electrification of fuel combustion processes

- In the agricultural sector, 0.63 $MtCO_2$ of emissions (9%) are from fuel combustion. This includes powering farming machinery, processing & refrigerating, producing packaging materials, manufacturing and transporting fertiliser etc.
- By electrifying 70% of fuel combustion applications, **~0.35 $MtCO_2$** of emissions could be avoided.

Feed additives

- Enteric fermentation is responsible for 57% of emissions from the agriculture sector, and feed additives can help reduce methane emissions from ruminant livestock.
- Effective additives include organic nutrients, fats and oils - feeding one type of seaweed at 5% of the diet has resulted in up to 95% reduction in methane emissions from cows without altering milk taste[3]. These additives can be easily combined with milk-optimising dry feed cycles. There are already plans for farm trials in Northern Ireland to look at the potential of seaweed to reduce emissions in dairy herds.
- From a typical feed additive with ~33% effective reduction[4], with a 50% take up rate for cattle in Northern Ireland, a sizeable annual reduction in enteric fermentation methane emissions could be achieved. This would amount to **0.44 $MtCO_2$** of savings.
- In Ireland, another project will study the effect on sheep[5]. If the effect is similar, a further saving of 0.05 $MtCO_2$ would be realised.

Soil pH optimization

- Northern Ireland land area is 66% grassland[6], of which only 36% is at optimum pH levels[7]. Adjusting soil pH by lime application improves effectiveness of fertilizers[8], improves yields and increases carbon sequestration by 25% to 50%[9].
- If 70% of grasslands in 2030 have optimum pH, an extra **0.07 $MtCO_2$** can be captured.
- An additional 50 units of Nitrogen per acre per year are released from soils with optimum pH[10], which can reduce the usage of inorganic N fertilizers and lead to emission savings of **0.10 $MtCO_2$**.

An Effective Additive - Asparagopsis Armata

System Value Impacts of Agriculture Interventions*

~0.3 Mt
CO_2 reduction from electrification of agriculture in 2030

~0.4 Mt
CO_2 reduction from feed additives in 2030

~0.2 Mt
CO_2 reduction from soil pH optimization in 2030

** Differences due to rounding*

Sources: (1) DAERA ; (2) SEAI; (3) Abbot et. Al; (4) Dairy Cares ; (5) Agriland ;(6) DAERA; (7) DAERA; (8) West Australia Government DPIRD; (9) Global Biochemical Cycles; (10) Smart Farming

6B. Decarbonisation of Agriculture

Animal production efficiency

- Implementing optimal selective breeding practices can reduce required life span of cows by 10%, without impacting the levels of milk production - increasing the Economic Breeding Index of the dairy herd - as found by the GreenBreed breeding optimisation programme[1].
- Taking into account 10% lifetime emission reductions from manure & enteric fermentation and a 50% uptake rate would result in a **reduction of 0.15 $MtCO_2$**.

Manure & slurry to produce biogas

- Manure management is responsible for 16% of all agriculture related CO_2 emissions[2]. Northern Ireland can reduce a portion of methane emissions from agriculture by converting manure into biogas through anaerobic digestion.
- Northern Ireland has more digestors per capita than England, Wales or Scotland. Currently there are 76 operational biogas plants, all with CHP as their output, and with a total generation capacity of 47 MW. Of these plants 64 are farm-fed and 12 are waste-fed[3]. Given efforts to reduce landfill levels in Northern Ireland and a reduction in the disposal of organic material, the majority of new biogas plants are expected to be farm-fed[4].
- Increasing the percentage of manure/slurry that is treated through AD from 5% to 15%, can provide **emission savings of 0.09 $MtCO_2$** from manure management in 2030.
- There are further circular economy benefits associated with the use of digestate by-product from anaerobic digestion to displace chemical fertiliser.
- These AD plants could also be used to create biomethane by upgrading the biogas produced – this biomethane could be used in transport and heating.
- Greenville Energy created the first plant in the world producing liquid biomethane on a farm, in Ardstraw[4], used to fuel other CHP engines[5].
- Additional measure: if 50% of manure/slurry is treated through AD (instead of 15%), an additional 0.3 $MtCO_2$ could be saved.

Greenville Energy AD Plant

System Value Impacts of Agriculture Interventions*

~0.2 Mt
CO_2 reduction from selective breeding in 2030

~0.1 Mt
CO_2 reduction from manure & slurry management in 2030

Sources: (1) Teagasc; (2) NAEI; (3) NNFCC; (4) Cryo Pur; (5) Granville Ecopark

** Differences due to rounding*

System Value outcomes for the energy system

System Value Dimension with Quantitative Analysis

System Value Dimension with Qualitative Analysis

Solution Area	GHG Emissions	Job Impact	Air Quality & Health	Energy Productivity and Systemic Efficiency	Resiliency & Security	Reliability and Service Quality	Flexibility	System Upgrade	Foreign Direct Investment	Cost and Investment Competitiveness
1 **Power System Decarbonisation**	**~1.5 Mt** CO_2 reduction in energy industries in 2030	**15k – 23k** Jobs from onshore and offshore wind expansion by 2030	**£30-45mn** Human health benefits in 2030	●	●	◑	●	●	●	£965 million to reinforce the transmission & distribution networks due to LCT uptake[1]
2 **Decarbonisation of Light Duty Transport**	**~1.4 Mt** CO_2 reduction from EVs in 2030	**300-800** Economy-wide jobs in 2030	**£85-127mn** Human health benefits in 2030	●	◑	◑	◑	●	◑	EVs will be cheaper than ICE cars & vans in all segments by 2027[2]
3 **Decarbonisation of Heavy Duty Transport**	**~0.4 Mt** CO_2 reduction from HGVs and Buses in 2030	**1k – 4k** Economy-wide jobs by 2030	**£4-6mn** Human health benefits in 2030	◑	◑	◑	◑	●	●	Electric vs diesel bus TCO comparable[3]; Hydrogen reaches TCO parity with electric by 2025[4]
4 **Decarbonisation of Housing**	**~1.2 Mt** CO_2 reduction from retrofitting & heat pumps in 2030	**84k-112k** Economy-wide jobs in 2030	**£49-74mn** Human health benefits in 2030	●	◑	◑	◑	◑	○	Upgrading 42% of C-G homes to EPC B & installing 118k heat pumps is expected to cost £6 bn
5 **Decarbonisation of Industry**	**~1.1 Mt** CO_2 reduction from efficiencies & F-Gas regulation in 2030		**£13-19mn** Human health benefits in 2030	●	◑	◑	●	◑	◑	Carbon price of £75/ton will encourage switching to low-carbon alternative fuels[5]

Sources: (1) NIE, tables 9 & 10; (2) Bloomberg BNEF; (3) Transport & Environment; (4) Element Energy; (5) 6th Carbon Budget, p306

System Value Dimension Benefit from Given Solution ● High Benefit ◑ Medium Benefit ○ Minimal-to-no Benefit

System Value dimensions – Energy system (1/3)

Benefits realised from the solutions in: Energy Productivity and Systemic Efficiency and Resiliency and Security

Solution	Energy Productivity and Systemic Efficiency	Benefit	Resiliency and Security	Benefit
Power System Decarbonisation	• Raising the ambition on storage solutions will enable significant capture of excess renewables generation • Greater interconnection with Scotland & Ireland can improve systemic efficiency by reducing congestion and curtailment		• Renewables expansion supported by next-generation power markets reduces import and physical supply risks • Renewable energy is significantly less reliant on on-the-ground workers to operate, facing less challenges in a pandemic	
Decarbonisation of Light Duty Transport	• Electric vehicles are more energy efficient than their fossil fuel counterparts, converting over 77% of the electrical energy to power at the wheel, whereas gasoline vehicles only convert 12%-30% of the energy stored in gasoline		• Converting on-road vehicles to locally sourced fuels (e.g. electricity, biogas, and green hydrogen) will significantly reduce fossil fuel import dependency	
Decarbonisation of Heavy Duty Transport	• Medium impact due to the diversity of solutions proposed • Greater deployment of vehicles powered by green hydrogen (FCEVs) and electricity (BEVs) could reduce renewables curtailment and improve efficiency relative to diesel powered vehicles			
Decarbonisation of Housing	• Improvements in energy productivity can be found through greater building efficiency, achieving same economic output for less consumption • Heat pump systems can have three to five times the efficiency of a comparable fossil fuel system		• Greater local energy usage through heat pump systems displacing imports of oil and gas • Reduced domestic energy consumption through comprehensive retrofit program will also reduce fossil fuel import dependency	
Decarbonisation of Industry	• Electric appliances are often more efficient than fossil fuel fired equivalents, reducing primary energy need • Industry can also collaborate on circularity and efficiency initiatives, recycling waste heat back into processes		• Efficiency savings and fuel switching in industry reduces fossil fuel import dependency	

Relative System Value dimension benefit for given recovery solution within market

 High benefit

 Medium benefit

 Minimal-to-no benefit

System Value dimensions – Energy system (2/3)

Benefits realised from the solutions in: Reliability and Service Quality and Flexibility

Solution	Reliability and Service Quality	Benefit	Flexibility	Benefit
Power System Decarbonisation	• Wind and solar can help meet growing demand to ensure sufficient supply on the system but would increase variability on the system • Greater interconnection can alleviate congestion • Storage can provide backup for interruptions	◐	• Increased battery storage, grid interconnection, digitalization and collaboration across entities can enable flexibility and more variable renewable generation mix	●
Decarbonisation of Light Duty Transport	• Smart charging and associated pricing schemes can serve as dynamic load to assist grid reliability, while serving as a revenue stream for EV owners • Roll-out of smart chargers with V2G/V2H/V2B capabilities will enable two-way electricity transfers, allowing for balancing services	◐	• Utilising V2G capabilities, EVs can act as flexible loads and decentralised storage resources, with smart charging as an enabler for EVs to provide flexibility (supported by dynamic or ToU tariffs and other incentives) • EVs can enhance the integration of solar and wind generation by aligning EV charging with resource availability	◐
Decarbonisation of Heavy Duty Transport		◐		◐
Decarbonisation of Housing	• Reduced maintenance needs from heat pump systems compared to conventional fossil fuel heating system	◐	• Aggregation of heat pumps can aid flexibility through coupled renewable energy and heating systems, smart load management	◐
Decarbonisation of Industry	• Efficiency can lower demand when the grid is strained, helping to prevent outages • Electrification enables more balancing participation for industry which supports service quality and reliability	◐	• Reduced, manageable load through smart efficiency solutions can help prevent grid peaks and match demand to supply • With electrified energy use, more plants could act as Demand Side Units	●

Relative System Value dimension benefit for given recovery solution within market

● High benefit ◐ Medium benefit ○ Minimal-to-no benefit

System Value dimensions – Energy system (3/3)

Benefits realised from the solutions in: System Upgrade and Foreign Direct Investment

Solution	System Upgrade	Benefit	Foreign Direct Investment	Benefit
Power System Decarbonisation	• Investment support to increase North-South interconnector capacity will be key to transform to a more variable system, where larger balancing and reserve areas will reduce congestion, variability, and individual reserve capacity requirements	●	• A high proportion of green energy will also make Northern Ireland a location of choice for companies looking to reduce Scope 2 emissions • This will attract FDI from global renewable generation and energy storage players	●
Decarbonisation of Light Duty Transport	• Investment in grid upgrades to enable smart charging and other emerging technologies such as V2G (enabled by digital technologies). It allows for a seamless shift to VRE sourced power, aligning with resource availability, as road transport transitions to EVs and electric buses/ HGVs	●	• Policies and incentives to switch to electric vans could attract FDI from logistics companies aiming to decarbonise their fleet	◐
Decarbonisation of Heavy Duty Transport		●	• Encouraging policy and infrastructure could attract FDI from companies looking to cut freight emissions and companies looking for markets for the sale of zero-emissions heavy duty vehicles	●
Decarbonisation of Housing	• Significant investment in energy efficiency measures such as retrofitting will reduce demand on the network	◐	• Limited system impact	○
Decarbonisation of Industry	• Demand side load shifting (enabled by digital technology investment) will create flexibility for the network	◐	• Incentives and support for industry to increase efficiency and electrify will attract FDI from industrial companies looking to reduce their carbon footprint	◐

Relative System Value dimension benefit for given recovery solution within market ● High benefit ◐ Medium benefit ○ Minimal-to-no benefit

System Value outcomes for Agriculture

Reducing emissions in agriculture yields environmental, economic and social benefits for the sector and the wider system

	Solution	Emissions Reduction	Overall System Value Benefits
i	**Electrification of Fuel Combustion Processes**	**~0.3 Mt** CO_2 reduction from electrification of agriculture in 2030	• Electrifying fuel combustion processes in agriculture will reduce emissions of air pollutants like NOx, SOx and particulate matter released when fossil fuels like diesel are burnt resulting in an air quality and health benefits. • Converting from fuel combustion processes to clean renewable sources with storage will create local jobs and increase energy resiliency due to reduced reliance on fossil fuel imports to power this sector. • Long term this can reduce operating costs as carbon price increases the cost of fossil fuels relative to renewable electricity.
ii	**Feed Additives**	**~0.4 Mt** CO_2 reduction from feed additives in 2030	• Feed additives provide a potentially highly effective way to reduce enteric fermentation without herd reduction thus protecting jobs, ensuring a just transition and protecting the economic contribution the agriculture sector.
iii	**Soil pH Optimization**	**~0.2 Mt** CO2 reduction from soil pH optimization in 2030	• Optimizing the pH of agricultural land by adding lime where appropriate will result in better grass quality and quantity, displace unnecessary fertiliser and concentrate feed inputs, reduce nutrient losses to watercourses, improve soil structure, permeability and carbon sequestration, and reduce rush cover on land[1]. • The cost reductions and the increase in quality and quantity of the grass will increase profitability.
iv	**Animal Production Efficiency**	**~0.2 Mt** CO_2 reduction from selective breeding in 2030	• Northern Ireland imported £208mn of feed in 2018 and from 2013 to 2018 was a net importer of feeding stuff for animals[2]. Selective breeding could reduce the amount of feed consumed over the lifetime of the herd[3], reducing reliance on feed imports. • Selective breeding provides both an emissions saving and economic benefit with increased profit per head of cows.
v	**Anaerobic Digesters to Produce Biogas**	**~0.1 Mt** CO_2 reduction from use of anaerobic digesters in 2030	• Local production of biogas that generates heat and electricity contributes to the renewable energy target. • Local production of biomethane using anaerobic digesters will reduce reliance on fossil fuel imports and provide an additional source of revenue to the agriculture sector, stimulating the local economy. • Northern Ireland imported fertilizers corresponding to the amount of £61.2mn[2] . Digestate from anaerobic digesters can be an effective fertiliser substituting for imports and creating a local fertiliser supply chain and new revenue for the sector.

Sources: (1) DAERA; (2) NISRA; (3) Selective Breeding