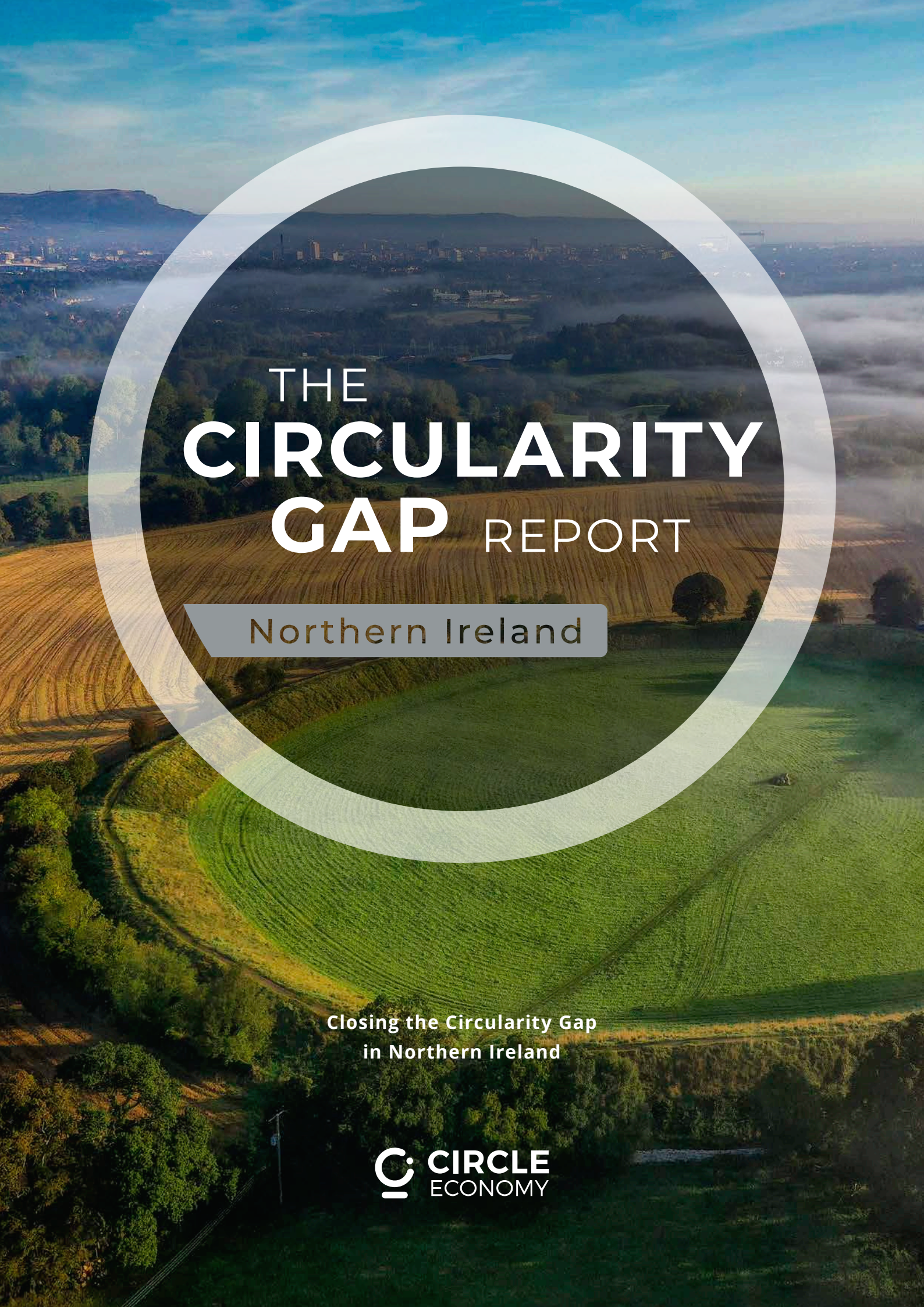


THE CIRCULARITY GAP REPORT

Northern Ireland

Closing the Circularity Gap in Northern Ireland

CIRCLE ECONOMY

CIRCLE ECONOMY

We are a global impact organisation with an international team of passionate experts based in Amsterdam. We empower businesses, cities and nations with practical and scalable solutions to put the circular economy into action. Our vision is an economic system that ensures the planet and all people can thrive. To avoid climate breakdown, our goal is to double global circularity by 2032.

PACE
Platform for Accelerating the Circular Economy

This report is published as an affiliate project of the Platform for Accelerating the Circular Economy (PACE). PACE is a global community of leaders, across business, government and civil society, working together to develop a collective agenda and drive ambitious action to accelerate the transition to a circular economy. It was initiated at the World Economic Forum and is currently hosted by the World Resources Institute.

BEHIND THE COVER

Early morning mist lifts from the Giants Ring in County Down, Northern Ireland.

Credit: Paul Lindsay, www.scenicirelandgallery.com

ADVISORY PANEL *COMMENTS AND INSIGHTS*

MIKE BRENNAN
Permanent Secretary at the Department for the Economy

'By establishing Northern Ireland's baseline circularity for the first time, this report will inform the development of the *Circular Economy Strategic Framework*. The seven 'what if' scenarios build understanding of the potential impact major interventions could have, whilst highlighting the economic, social and environmental opportunities a transition to greater circularity can bring. This independent research is just one part of the evidence base that we are considering as we develop and shape the Framework.'

DARRAGH MCCONVILLE
Chair at Recycle NI

'It is clear that the transition to a circular economy is vital if we are to maintain economic growth, whilst ensuring the sustainability of our planet for future generations. This report clearly highlights the scale and urgency of the task Northern Ireland is facing, and illustrates the need for a collaborative approach.'

EIMEAR MONTAGUE
Northern Ireland Project Manager at Northern Ireland Resources Network

'Transitioning to a circular economy offers a multitude of environmental, economic and social benefits for Northern Ireland. This report is a significant milestone as it establishes Northern Ireland's current circularity, and presents a set of circular scenarios which, if adopted, will allow Northern Ireland to realise these opportunities, significantly cutting its material footprint.'

MEL CHITTOCK
Interim Chief Executive at Invest Northern Ireland

'The Department for the Economy's 10X Vision aims to establish Northern Ireland as an exemplar in the circular economy. Northern Ireland's businesses are natural allies in this transition. Invest Northern Ireland will work to support this ambition and to help achieve net-zero carbon ambitions and protect our environment. We will aim to support and enable businesses in optimising resource use and implementing energy saving initiatives; and will continue to work in collaboration with all players in the value chain.'

DR MICHAEL SHAW
Managing Director at RPS Northern Ireland

'*The Circularity Gap Report* represents a strong step towards identifying a route towards a circular economy in Northern Ireland, particularly relevant in light of the global climate emergency. The report lays out the baseline situation for Northern Ireland, which will allow us to measure the impact of our actions in the coming years.'

DAVID ROBERTS
Director of Strategic Development at Tourism Northern Ireland

'This report provides valuable insights and ideas that will empower us to work with the government and businesses as we accelerate on our journey towards sustainable tourism. By promoting local visitor experiences and produce, the sector can further cut its environmental impact, support jobs in a number of sectors and act as an enabler for the circular economy.'

PROFESSOR ELIZABETH MAGOWAN
Director of Sustainable Agri-Food Science at the Agri-Food & Bio Sciences Institute

'While much more work is needed to explore a range of 'what if' scenarios and especially their wider implications on Northern Ireland's economy and societal health, this report is interesting and provocative. It presents data and concepts in a new light—and through the presentation of seven theoretical scenarios, it will certainly contribute to the wider debate as to how Northern Ireland can boost its circularity to address its green growth ambitions.'

PETER LAYBOURN
Chief Executive at International Synergies Limited

'I welcome this report. It recognises the key role industrial symbiosis is playing through the *Resource Matching Service*, and also recognises its importance for planning and innovation. The utilisation of industrial symbiosis to boost economic growth whilst reducing Scope 3 emissions and increasing resilience will be key in the future.'

TIM WALKER
Chief Executive at arc21

'For some time, I've been an avid supporter of circular economy thinking. It's great to see the publication of this timely report, championed by the Department for the Economy, which highlights how to manage resources better and provides a brave first step in identifying sectors and material flows that could be pathfinders for Northern Ireland. There's much to be done and this report provides a great foundation upon which the next steps can be taken. This will require new ways of working and new collaborations—but promises to be an exciting journey.'

PROFESSOR JOHN BARRY
Co-Chair of the Belfast Climate Commission and Professor of Green Political Economy at Queen's University Belfast

'This report is an evidence-based 'wakeup call' in relation to the unsustainable linear economic model we currently have in Northern Ireland. I welcome the report's call for radical and transformative changes, including (as it highlights) that as we shift Northern Ireland's economy towards true circularity, our notion of 'progress' must be broadened beyond GDP-based economic growth.'

EXECUTIVE SUMMARY

Northern Ireland is 7.9% circular—leaving a Circularity Gap of more than 92%. This means that the vast majority of resources Northern Ireland uses to satisfy its needs and wants come from virgin sources. The country consumes a total of 33.6 million tonnes of materials each year, equal to 16.6 tonnes per capita—far surpassing the global average of 11.9 tonnes. In meeting the needs of its residents—and exporting elsewhere in the world—Northern Ireland extracts a moderate 14.6 tonnes of resources per capita per year within its borders, contributing to its high material footprint: this rate of extraction far exceeds the UK average, which sits at 5.5 tonnes per capita. Additionally, our analysis found that almost one-tenth of the employed labour force in Northern Ireland (8.9% or 69,600 workers) are contributing to the circular economy, either directly or indirectly. The other 91% of the workforce is still operating in a linear economy, in alignment with the present take-make-waste paradigm.

The material footprint behind Northern Ireland's resource use. This report analyses how resources—metal ores, non-metallic minerals, biomass and fossil fuels—are used to meet the country's needs, from Housing and Mobility to Food and Consumer Goods. Northern Ireland consumes 31 million tonnes of virgin materials on a yearly basis. Although a moderate figure when taken on a per capita basis, it represents a tiny sliver of the global population (0.025%) and accounts for a relatively proportional 0.03% of the world's material footprint. It also still relies heavily on fossil fuels to maintain industry, heat homes and power transport—as well as to extract and process materials for consumption. The country's low population density, requiring a higher use of resources for the provision of social amenities—roads and electrical infrastructure, for example—also contributes to the rather high levels of material consumption per capita. Its moderately high material footprint is strongly tied to its emissions: with a consumption-based carbon footprint of 23 million tonnes, the average resident of Northern Ireland represents 9.1 tonnes of emissions per year—nearly double the global average. There's a strong link between material use and greenhouse gas emissions: by advancing circularity, the country also opens up avenues for slashing emissions and reaching net-zero goals.

Booming construction and abundant farmland both contribute to Northern Ireland's large footprint. Sectors such as construction and agriculture contribute hugely to the country's high material footprint and emissions profile. To house a growing population—one with an increased appetite for living alone—resource-intensive construction is on the rise. Its sparsely populated demographic structure means that building infrastructure—such as public amenities and roads connecting rural towns—will have a greater impact per capita. Meanwhile, the country produces more than enough food to feed its residents, and is a net exporter in nutrient and trade balance terms, with an intensive livestock production model that is increasingly dominating the agricultural sector. Only 5% of the country's vast farmland is used to produce crops, owing to its climate, soils and topography: grasslands are dominant, with 80% of farms raising cattle and sheep. While farms have boasted efficiency improvements in recent years—especially for dairy production—production has continued to swell, and emissions and pollution have grown in tandem. The result: Northern Ireland's two key sectors are consuming plenty of resources—contributing to environmental degradation—and generating substantial volumes of waste and emissions. While this is common for a high-income country like Northern Ireland, it calls for an approach that goes beyond just cycling. To this end, this report provides means for the country to cut its material footprint while also doubling its circularity.

Opening up the Circularity Gap. Northern Ireland's Circularity Metric of 7.9% doesn't mean that 92.1% of the materials flowing through its economy go to waste or are inherently 'bad'. The Circularity Gap is composed of a range of elements: many materials (around 34%), for example, are added to stock mainly in the form of buildings and infrastructure, and while materials in this category can be cycled, quite some time will pass before this is possible. Buildings, for example, last many decades before their end-of-life—so good design is crucial to ensure that end-of-life cycling will be feasible and of high value. Another 23% of materials are represented by biomass with the potential for cycling, such as food crops, wood products and biochemicals. Inherently non-circular flows, such as fossil fuels, and non-renewable inputs represent approximately 17% and 18% of material use, respectively, while non-renewable biomass—biomass that is not carbon neutral—represents around 1%. In total, these three materials represent 36% of Northern Ireland's indicator set. This paints a picture of the country's strong dependence on fossil fuels, as well as its somewhat less-than-ideal cycling statistics for waste streams like metals and plastics. Northern Ireland's most critical goal will be cutting this 36% while boosting its Circularity Metric—especially as stock build-up will continue to grow due to demographic factors, for instance.

A set of circular strategies to narrow the Circularity Gap in Northern Ireland. To bridge the Gap, this report explores seven 'what-if' scenarios that apply strategies to strengthen circularity, cut material use and transform Northern Ireland's economy. The scenarios are 1) Nurture a circular food system, 2) Build a circular built environment, 3) Champion circular manufacturing, 4) Power clean mobility, 5) Leverage public procurement, 6) Journey toward sustainable tourism, and 7) Welcome a circular lifestyle. While individual scenarios may have limited impact, all together, they can more than double Northern Ireland's circularity—bringing the Metric to 16.1%—while cutting its material footprint by a highly significant 48%, reducing it to a total of 16 million tonnes. This equates to around 8 tonnes per person per year—a figure in line with the scientifically-agreed upon maximum to remain within the planet's ecological limits.[1,2] Other benefits are numerous: from improving health and well-being, cutting greenhouse gas emissions and pollution and boosting biodiversity to nurturing a stronger sense of community and increasing resilience. In line with the strategies given above, this report dives into eight key focus areas to be prioritised by Northern Ireland's upcoming circular economy strategy, highlighting how circularity can be realised in four economic sectors—Bioeconomy and agriculture, Construction and built environment, Advanced manufacturing, and Tourism—and for four material streams—Food, Electronics, Packaging and Textiles.

Northern Ireland's economy is full of potential—but there are limitations to how much we can increase its Circularity Metric. It's not feasible to aim for 100% circularity in our modern, highly complex and globalised world economy. Northern Ireland's consumption drives resource extraction and waste generation abroad as well as within its borders, as the country exports materials primarily to the rest of the UK and the Republic of Ireland while consuming goods imported from around the world. Controlling the circularity of imports is difficult—and what's more, Northern Ireland extracts substantial amounts of biomass and mines non-metallic minerals, which can be largely non-circular processes. And as long as the population continues to grow and current consumption patterns prevail, large quantities of materials will be needed to sustain the lifestyles of Northern Ireland's residents: for example, to develop the housing, infrastructure and services needed to support them, which will lock materials into stock and diminish cycling potential for decades to come. As of yet, circular business models are often unable to compete at scale, as regulatory and fiscal frameworks still disproportionately benefit deeply-ingrained linear thinking and approaches. Doubling current circularity and reaching 'only' 16% circularity is, therefore, a worthy goal—especially considering the impact this would have on cutting the material footprint by half and reducing emissions and limiting global warming to 1.5-degrees.[3] The circular economy brings transformative power: small changes can elicit huge impact.

Northern Ireland's workforce as an enabler of the circular transition. If well-designed, a labour market can anticipate and prepare for the transition to a circular economy—also helping accelerate this shift. Our analysis found that just under one-tenth of Northern Ireland's jobs contribute to the circular economy, either directly or indirectly. The vast majority of these circular jobs—just over 78% of the total—are indirectly circular: mainly generated through demand for core circular products or services by the manufacturing, health and social work, administrative services and construction sectors, this goes to show

how jobs across sectors will have a key role to play in supporting the circular economy. Increasing circular jobs can be achieved by stimulating core sectors—from renewable energy and repair and maintenance, to reuse and recycling—as well as redirecting enabling sectors such as finance, research, design and digital services to serve key tenets of circularity, such as waste prevention or regeneration. Appropriate education and training, work-based learning and apprenticeship pathways, and a supportive policy environment will all be crucial levers to drive demand for circular skills, and help ensure that the workforce accelerates the circular transition while enjoying decent, just work opportunities: closing the Circularity Gap must be done in an equitable way, that future proofs Northern Ireland's labour market and benefits work and workers.

A holistic approach to enable systemic change. To realise the full potential of Northern Ireland's circular future, practical pathways that are aligned to the local context, incentives and mandates are crucial. To this end, shifting towards more circular business models, boosting investment in waste management infrastructure and developing supportive policy incentives will be key. Changes in taxation will also have a critical role to play in providing actors with the right economic incentives to shift their activities, as well as steer consumer demand. At the same time, a social shift away from consumerism and towards a more sustainable, community-based lifestyle that embraces sharing over ownership will also be needed to advance the necessary changes. Establishing and developing clear metrics and goals can help to drive national progress towards circularity. Additionally, ensuring a national coalition for action is formed that is both diverse and human-centric can help to strengthen local and regional knowledge and momentum toward circularity and consumption reduction.

The circular economy is a means to an end: a safe and just space for people and the planet. Narrowing the Circularity Gap and slashing material consumption serves this higher objective by relieving environmental pressures and resource depletion in Northern Ireland and abroad, while mitigating social inequalities (if done well and planned with this intention in mind). Circular strategies and circular business models are also a means to enhance emissions abatement and reduce extraction—thereby improving supply security and price stability when materials are kept in circulation. By encouraging greater access and even distribution of resources, circularity also has a role to play in safeguarding social equity. The circular economy is a means to achieving the defining goal of a world—and country—that is ecologically safe and socially just. For the circular economy in Northern Ireland to benefit people and communities, pathways to develop the right skills, interventions to strengthen educational institutions and community-led, informal learning and coaching can be harnessed.

The time for transformational change is now. Current environmental efforts are centred around decarbonisation. Although undeniably worthwhile, this does little to tackle Northern Ireland's high levels of consumption. The resounding message is clear: for Northern Ireland to become serious about sustainability and meet its net-zero and ecological goals, the country will need to overhaul how it extracts, processes, consumes and disposes of materials. With a policy docket that has increasingly aligned with sustainability agendas over recent years—and political leaders more inclined to feature circularity high on the menu of options for emissions abatement—the country is well-poised to do so. Ultimately, Northern Ireland's vision of the circular economy centres on sustainable development: a means for prosperous lives within the ecological limits of our planet, with the workforce an essential lever for achieving this goal. Our circular guidelines can assist decision makers in making the circular economy a top priority. Without metrics and measurements, it's hard to take action. This report lays out quantifiable insights that will help the country cut its consumption in half—bringing it within the ecological limits of our planet. Northern Ireland's sustainability goals are bold—and they necessitate a bold transformation. This big shift is the circular economy.

CONTENTS

GLOSSARY

Consumption refers to the usage or consumption of products and services meeting (domestic) demand. *Absolute consumption* refers to the total volume of either physical or monetary consumption of Northern Ireland's economy as a whole. In this report, when we talk about *consumption* we are referring to absolute consumption.

Domestic Extraction (DE) is an environmental indicator that measures, in physical weight, the amount of raw materials extracted from the natural environment for use in the economy. It excludes water and air. In this report, we are referring to extraction domestically within Northern Ireland. [Source]

Domestic Material Consumption (DMC) is an environmental indicator that covers the flows of both products and raw materials by accounting for their mass. It can take an 'apparent consumption' perspective—the mathematical sum of domestic production and imports, minus exports—without considering changes in stocks. It can also take a 'direct consumption' perspective, in that products for import and export do not account for the inputs—be they raw materials or other products—used in their production. [Own elaboration based on Source]

Domestic processed output refers to 'the total mass of materials which have been used in the national economy, before flowing into the environment. These flows occur at the processing, manufacturing, use, and final disposal stages of the economic production-consumption chain.' [Source]

Economy-wide material flow accounts (EW-MFA) are a 'statistical accounting framework describing the physical interaction of the economy with the natural environment and with the rest of the world economy in terms of flows of materials.' [Source]

Environmental stressor, in Input-Output Analysis, is defined as the environmental impact occurring within the region subject to analysis. There is therefore an overlap between the stressor and the footprint, as they both include the share of impact occurring within a region as a result of domestic consumption. This is how they differ: while the rest of the stressor is made up of impacts occurring within a region as a result of consumption abroad (embodied in exports), the footprint includes impacts occurring abroad as a result of domestic consumption (embodied in imports).

Greenhouse gases (GHG) refers to a group of gases contributing to global warming and climate breakdown. The term covers seven greenhouse gases divided into two categories. Converting them to **carbon dioxide equivalents** (CO_2e) through the application of characterisation factors makes it possible to compare them and to determine their individual and total contributions to Global Warming Potential (see below). [Source]

High-value recycling refers to the extent to which, through the recycling chain, the distinct characteristics of a material (the polymer, the glass or the paper fibre, for example) are preserved or recovered so as to maximise their potential to be re-used in a circular economy. [Source]

Materials, substances or compounds are used as inputs to production or manufacturing because of their properties. A material can be defined at different stages of its life cycle: unprocessed (or raw) materials, intermediate materials and finished materials. For example, iron ore is mined and processed into crude iron, which in turn is refined and processed into steel. Each of these can be referred to as materials. [Source]

Material footprint, also referred to as Raw Material Consumption (RMC), is the attribution of global material extraction to the domestic final demand of a country. In this sense, the material footprint represents the total volume of materials (in Raw Material Equivalents) embodied within the whole supply chain to meet final demand. The total material footprint, as referred to in this report, is the sum of the material footprints for biomass, fossil fuels, metal ores and non-metallic minerals. [Source]

Material flows represent the amounts of materials in physical weight that are available to an economy. These material flows comprise the extraction of materials within the economy as well as the physical imports and exports (such as the mass of goods imported or exported). Air and water are generally excluded. [Source]

Raw Material Equivalent (RME) is a virtual unit that measures how much of a material was extracted from the environment, domestically or abroad, to produce the product for final use. Imports and exports in RME are usually much higher than their corresponding physical weight, especially for finished and semi-finished products. For example, traded goods are converted into their RME to obtain a more comprehensive picture of the 'material footprints'; the amounts of raw materials required to provide the respective traded goods. [Source]

Raw Material Consumption (RMC) represents the final domestic use of products in terms of RME. RMC, referred to in this report as the 'material footprint', captures the total amount of raw materials required to produce the goods used by the economy. In other words, the material extraction necessary to enable the final use of products. [Source]

Resources include, for example, land, water, air and materials. They are seen as parts of the natural world that can be used for economic activities that produce goods and services. Material resources are biomass (like crops for food, energy and bio-based materials, as well as wood for energy and industrial uses), fossil fuels (in particular coal, gas and oil for energy), metals (such as iron, aluminium and copper used in construction and electronics manufacturing) and non-metallic minerals (used for construction, notably sand, gravel and limestone). [Source]

Secondary materials are materials that have already been used and recycled. This refers to the amount of the outflow which can be recovered to be re-used or refined to re-enter the production stream. One aim of dematerialisation is to increase the amount of secondary materials used in production and consumption to create a more circular economy. [Source]

Sector describes any collective of economic actors involved in creating, delivering and capturing value for consumers, tied to their respective economic activity. We apply different levels of aggregation here—aligned with classifications as used in Exiobase V3. These relate closely to the European sector classification framework NACE Rev. 2.

Socioeconomic metabolism describes how societies metabolise energy and materials to remain operational. Just as our bodies undergo complex chemical reactions to keep our cells healthy and functioning, a nation (or the globe) undergoes a similar process—energy and material flows are metabolised to express functions that serve humans and the reproduction of structures. Socioeconomic metabolism focuses on the biophysical processes that allow for the production and consumption of goods and services that serve humanity: namely, what and how goods are produced (and for which reason), and by whom they are consumed. [Source]

Territorial-based carbon footprint is based on the traditional accounting method for GHG emissions, with a focus on domestic emissions, mainly coming from final energy consumption. A **consumption-based carbon footprint** uses input–output modelling to not only account for domestic emissions but also consider those that occur along the supply chain of consumption (for example, accounting for the embodied carbon of imported products).

Total material consumption is calculated by adding Raw Material Consumption (material footprint) and secondary material consumption (cycled materials).

1. INTRODUCTION

We are living in the Anthropocene: a new geological epoch where our human imprint on the planet has caused increasing devastation to the natural world.[4] According to our global *Circularity Gap Report 2020*,[5] the global economy is only 8.6% circular: the vast majority of the resources we consume come from virgin sources, while waste is par for the course. Meanwhile, our latest Report found that on the road from COP25 in Paris to COP26 in Glasgow, we have collectively consumed more than half a trillion tonnes of materials.[6] Our linear 'take-make-waste' economy has made throw-away culture the norm, putting increasing pressure on the vital ecosystems and climate that our very existence depends upon. Our analysis finds that Northern Ireland's Circularity Metric sits just below the global average at 7.9%—and that less than one-tenth of jobs (8.9%) currently contribute to the circular economy. While the country is making progress in shifting away from a linear economy, through decarbonising electricity production and increasing recycling efforts, there is still a long way to go in achieving a more circular economy. Northern Ireland has a moderately high material footprint of 16.6 tonnes per person per year—considerably above the global average of 11.9 tonnes per person per year. With its strong agricultural sector and close ties with the rest of the UK, Ireland and other countries abroad, Northern Ireland has an important role to play in reducing pressure on material resources whilst maintaining its residents' high standard of living. This will require a deep systemic shift and total reimagining of how we relate to the material world: the circular economy.

THE RISKS OF THE LINEAR ECONOMY

Northern Ireland's economy relies heavily on virgin resource extraction and generates vast amounts of waste. Like much of the globe, Northern Ireland functions within the linear economy: the dominant economic model characterised by 'take-make-waste' processes powered by fossil fuels. Our economy consumes over 100 billion tonnes of materials each year, with a Circularity Metric of 8.6%: the vast majority of the materials we use to feed our everyday lifestyles come from virgin sources. It also relies on heavy extraction and emissions-intensive processes to fulfil our societal needs—be they Housing, Nutrition or Mobility. Northern Ireland's material consumption—a total of 33.6 million tonnes—is putting intense pressure on natural ecosystems, and far surpasses what can be considered 'sustainable'. And while the country is making progress in shifting away from fossil fuels and separating more household waste, seriously pursuing a circular economy will require radical changes. All elements of the circular economy must be leveraged to preserve material value at the highest extent possible, eliminate waste and pollution, keep materials in use and regenerate natural systems.[7] Until Northern Ireland does this, it will continue to miss out on key opportunities to cut resource extraction and optimise consumption.

THE ROAD TO CIRCULARITY

Northern Ireland is 7.9% circular: sitting just below the global average, there is still a long road to circularity ahead. This means that of the 33.6 million tonnes of materials the country consumes, 92.1% are not cycled back into the economy: 11.3 million tonnes are used for stock—like buildings and infrastructure—while a staggering 20.7 million tonnes are dissipated into the environment or wasted (see pages 34, 35 for more information). But a low cycling rate only reveals one part of a larger picture: the country is also characterised by relatively high consumption rates: 16.6 tonnes per capita per year, slightly lower than the UK average of 18.4 tonnes per capita per year[8] but substantially more than the global average of 11.9 tonnes per capita per year. Aside from high consumption levels, a major influencing factor for such a high per capita material footprint is Northern Ireland's relatively low population density compared to, for example, England, which results in a less efficient use of resources to provide for social amenities and services: rural roads, for example, service far fewer people. This global average rate of consumption already puts too much pressure on the planet and would require 1.75 Earths to sustain[9]—and this trend has been increasing in Northern Ireland in recent years. Material- and emissions-intensive sectors like construction and agriculture account for the bulk of the country's material use and waste generation. Current trends—such as a growing population and increasing prevalence of single-occupant households, in addition to a very high proportion of land used for livestock grazing and cattle ranching—only indicate that material use, emissions and waste are set to increase. All of this is typical of a high-income trade country: Northern Ireland's moderately high consumption rate is comparable to neighbouring Western European countries. The country's extraction rate rests somewhat below its material consumption. In satisfying the needs of its population—and exporting elsewhere in the world—Northern Ireland extracts 14.6 tonnes of resources per capita per year within its borders, rising above the global average of 12.3 tonnes per capita per year. A sharp change is needed—and by eliminating waste and pollution, keeping products and materials in use, and regenerating natural systems, a circular economy can allow Northern Ireland to pivot away from its 'take-make-waste' model and meet the needs of its residents while remaining within planetary boundaries.[10]

Until very recently, Northern Ireland remained the only part of the UK without climate legislation—but now, its first laws have passed to tackle the climate crisis with a firm goal to reach net-zero by 2050.[11] We know from the 2021 edition of the *Circularity Gap Report* that 70% of emissions stem from material use and handling: decreasing consumption through circular strategies is inextricably tied to emissions reduction agendas. But a focus on climate change—just one of nine planetary boundaries—isn't enough. Northern Ireland's priority should also centre on integrating circularity into its environmental strategy to cut its material consumption alongside its carbon footprint. This will bring benefits beyond emissions reductions, from more prosperous ecosystems and clean air and water to flourishing biodiversity. While Northern Ireland's *10x Economy strategic vision*,[12] *Green Growth Strategy*,[13] and *Environment Strategy*[14] along with existing action plans—such as the Skills,[15] Food,[16] and Energy[17] strategies—provide some direction for shifting to a circular economy, there is still considerable room for new and reformed policy instruments, material reduction targets and concrete plans moving forward.

A SOCIAL AND ECONOMIC CROSSROADS

The circular economy is a means to an end for Northern Ireland: the end goal being a country where social needs are met within the ecological limits of the planet. Social considerations—such as decent employment opportunities and securing residents' livelihoods—should be front and centre as Northern Ireland pursues this aim. The country is already focusing on eight key areas to advance the circular economy: four economic sectors (tourism, construction and the built environment, bioeconomy and advanced manufacturing) and four material flows (textiles, electronics, food and packaging). However, conflicting interests exist across sectors alongside a deeply entrenched focus on GDP-based economic growth. Strong commitments will be needed to steer action. A deeper understanding that current lifestyles—marked by high consumption—are unsustainable is also needed, necessitating a mindset shift away from the idea that 'all we need to do to go circular is recycle'. As we work towards true circularity, our notion of progress must also be broadened beyond GDP growth—incorporating social and environmental indicators in our definition of wealth, prosperity and well-being. While the absolute decoupling of resource use and economic growth is theoretically ideal, it is also unattainable. Although Northern Ireland has achieved relative decoupling[18]—its GDP has grown at a faster rate than its material use—efficiency gains won't be enough if they're met by ever-rising extraction and consumption, domestically or abroad. A circular economy will require Northern Ireland to reimagine and redesign the way in which extracted resources are transformed into social benefits.

AN ECONOMY FULL OF POTENTIAL

With a Circularity Metric just below the global average, Northern Ireland's opportunities to boost its circularity are abundant. Initial efforts to decarbonise electricity generation have set a precedent for the systemic change necessary—and expected—for the coming years. Our analysis finds that there are several avenues for boosting Northern Ireland's Metric: from rethinking the mobility system and the way housing is built and managed, to transforming diets and lifestyles. Combined, these strategies could more than double the Metric, bringing it from 7.9% to 16.1%. While this increase may seem slim, our *Circularity Gap Report 2021* found that doubling global circularity—bringing it to 17%—could be enough to limit global warming to 1.5-degrees, circumventing the worst impacts of climate breakdown.[19] Boosting Northern Ireland's Metric to 16.1% would bring it nearly in line with what should be the global goal—and what's more, our strategies could cut material consumption by 48%, bringing it down to 16 million tonnes. Even a small increase in circularity is powerful and will bring benefits beyond reductions in emissions and material use. Northern Ireland has a solid foundation from which to implement the strategies proposed in this report. Its policy framework has increasingly aligned with sustainability agendas over recent years and political leaders are supportive of putting the circular economy at the centre of future development strategies.

Current efforts are not enough to fight climate breakdown and relieve environmental pressures. While the share of renewable electricity has increased significantly during the past decade, core issues such as the massive environmental impact of agriculture, lack of innovation in the construction sector and the difficulty of effectively organising stakeholder engagement remain vital obstacles. The circular economy presents a holistic, integrated approach to these seemingly disparate issues: change that cuts across sectors and targets every aspect of materials' lifetimes, from extraction to transformation to use and disposal (or reuse). In this report, we present seven scenarios that will help Northern Ireland to cut its material footprint by nearly half, substantially increase its cycling power and bring the country from theory to action: the truly transformative, systemic change the shift to a circular economy needs to see.

AIMS OF THE *CIRCULARITY GAP REPORT NORTHERN IRELAND*

1. Provide a snapshot of how circular Northern Ireland is by applying the Circularity Metric.
2. Identify how materials flow throughout the economy and how they may limit or boost the current Circularity Metric.
3. Spotlight possible interventions within significant industries that can aid Northern Ireland's transition to becoming circular and reducing its material footprint and the human capital required to do so.
4. Spotlight avenues for governments to create a shared vision with local businesses and consumers to encourage circular consumption in the identified focus areas of bioeconomy and agriculture, construction and the built environment, tourism, advanced manufacturing, textiles, electronics, food and packaging.
5. Communicate a call to action based on the above analysis, to inform future goal setting and agendas.

2

METRICS FOR CIRCU-LARITY

Measuring the circularity of Northern Ireland

Measurements are critical to understanding the world around us. As it becomes more urgent for us to adapt our socioeconomic system and become more circular, we need to provide a tactical approach for measuring the transition. In the first edition of the global *Circularity Gap Report*, in 2018, Circle Economy launched the Circularity Metric for the global economy. This analysis adapts the Metric to suit a national profile. This section explains how this report has assessed Northern Ireland's circularity and introduces supporting metrics that help us understand the significant material flows that contribute to the country's large Circularity Gap. These additional insights allow us to formulate a plan for moving toward greater circularity: they provide an initial assessment by locating circular opportunities and priorities in material flows. By measuring circularity in this way, businesses and governments can track their circular performance over time and put trends into context, as well as engage in uniform goal-setting and guide future action in the most impactful way.

MEASURING CIRCULARITY: A MEANS TO AN END

The circular economy is a big picture and holistic idea. Ultimately, it is a means to an end—the end being a socially just and ecologically safe space, where our environment can flourish and people can thrive. Exactly *how* the circular transition can deliver more beneficial social and environmental outcomes is not a question with just one right answer, however. There is no simple straight-line solution and the feedback loops in the system run in all directions.[20] In particular, three connected spheres need to be taken into account: 1) how resources are put to work, to 2) deliver social outcomes, via 3) provisioning systems. Provisioning systems comprise physical systems such as road infrastructure, technologies, and their efficiencies[21] and social systems, which include government institutions, businesses, communities and markets.[22] Provisioning systems are the essential link between biophysical resource use and social outcomes. For example, different forms of transportation infrastructure (railways versus motorways or car-sharing versus car ownership) can generate similar social outcomes, but at very different levels of material use. This is how the circular economy can transform societies, allowing us to thrive with minimal environmental impact.

In this analysis, we take the socioeconomic metabolism of a country—how resources flow through the economy and are in long-term use—as the starting point for measuring and capturing its level of circularity. We also consider the importance of reducing consumption. This is because impact prevention through reduced demand is an important first step to take before exploring other mitigation options—a tenet reflected by environmental management hierarchies wherein reductions of production and consumption, narrowing flows, is always the preferred and most effective strategy.

To ensure our data is in line with the reality of Northern Ireland, we worked with Northern Ireland's Statistics and Research Agency (NISRA), Department of Agriculture, Environment and Rural Affairs (DAERA), Department for the Economy (DfE), and Ricardo Energy & Environment as official data providers. More information on the data sets used can be found in the methodology document.[23]

MATERIAL FLOWS AND FOOTPRINTS

Societies consume materials and energy to maintain themselves. Figure one provides a schematic depiction of the socioeconomic metabolism of Northern Ireland. It depicts the amounts of materials (clustered into four key resource groups) embodied in the inputs and outputs of highly aggregated industry groups. Due to the level of detail and intricacy of how materials flow through an economy, we are not able to visualise all flows and all sectors. Because the majority of materials flow through just a handful of sectors in an economy, we have limited our visualisation to show these. The left side shows the four resource groups as a result of direct domestic extraction. These are minerals (limestone, copper and lithium, for example), metal ores (iron, cobalt and titanium dioxide, for example), fossil fuels (petroleum, for example) and biomass (food crops and forestry products, for example).

We also see on the left the volume of resources entering the provincial economy through imports. These are represented in terms of Raw Material Equivalents (RMEs)—the amount of material extraction needed, anywhere in the world, to produce a traded product. Together, the domestic extraction and the RME of imports comprise the total inputs (raw material input) of a national economy (read more on this on page 26).

Once in the economy, extracted or traded raw materials as well as the traded or domestically produced components, semi-products and products undergo operations that either transform them into end products or make them part of the production process of another end product. Beginning with the extraction, the resources are processed, such as metals from ores, which are manufactured into products in the produce stage. The finished products go towards satisfying societal needs and wants such as Nutrition, Housing and Mobility, or they are exported.

Of these materials entering the national economy every year, the majority are utilised by society as short-lived **Products that Flow**—reaching their end-of-use typically within a year, such as an apple, food packaging or a standard toothbrush. The end-of-use resources of these products are typically either lost or cycled back into the economy. The remaining materials enter into long-term stock—referred to as **Products that Last**. These are products such as capital equipment, buildings and infrastructure.

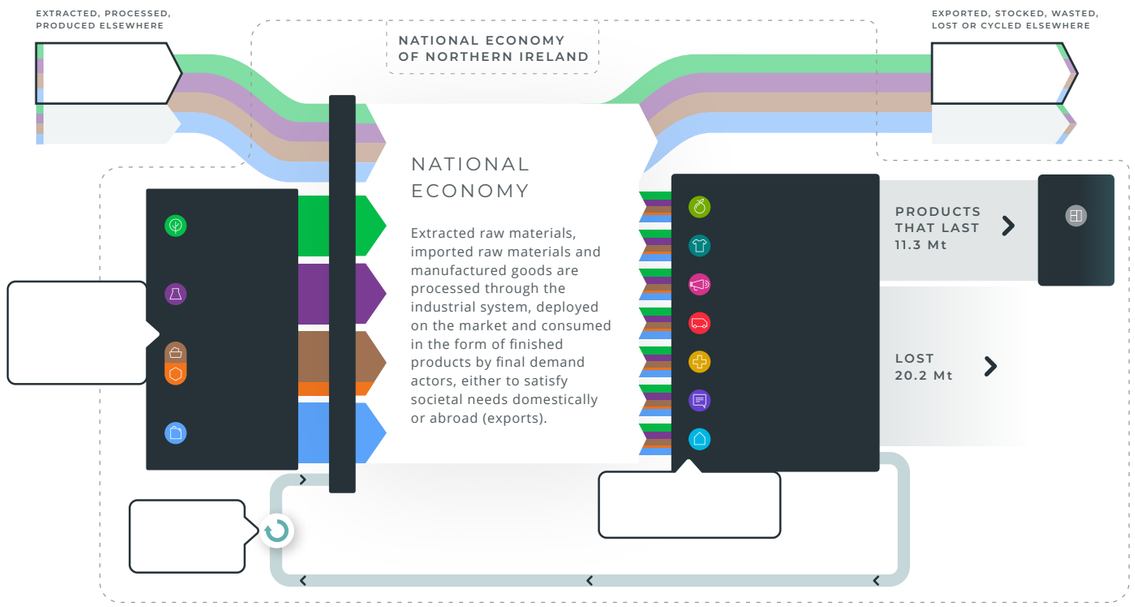


Figure one shows a schematic overview of the socioeconomic metabolism of a country. Note: material stock and cycled material flows are not scaled to proportion.

THE CIRCULARITY METRIC EXPLAINED

In order to capture a single metric for circularity in an economy, we need to reduce this complexity somewhat. So, we take the metabolism of a national economy—how materials flow through the economy and are used over the long-term—as the starting point. This approach builds on and is inspired by the work of Haas et al.[24] and continues the approach applied in all other national *Circularity Gap Reports*. Taking an 'X-ray' of the economy's resource and material use, we consider six fundamental dynamics of what the circular economy transition aims to establish and how it can do so. This translates into two objectives and four strategies, based on the work of Bocken et al. (2016).[25]

The core objectives are:

- **Objective one:** Resource extraction from the Earth's crust is minimised and biomass production and extraction are regenerative;
- **Objective two:** The dispersion and loss of materials is minimised, meaning all technical materials have high recovery opportunities, ideally without degradation and with optimal value retention; emissions to air and dispersion to water or land is prevented; and biomass is optimally cascaded.

The four strategies we can use to achieve these objectives are:

- **Narrow flows—use less:** The amount of materials (including fossil fuels) used in the making of a product or in the delivery of a service are decreased. This is through circular design or increasing the usage rates of materials and products. In practice: Sharing and rental models, material lightweighting (mass reduction), multifunctional products or buildings, energy efficiency, digitisation.
- **Slow flows—use longer:** Resource use is optimised as the functional lifetime of goods is extended. Durable design, materials and service loops that extend life, such as repair and remanufacturing, both contribute to slowing rates of extraction and use. In practice: Durable material use, modular design, design for disassembly, repair, remanufacturing, refurbishing, renovation and remodelling over building new structures.
- **Regenerate flows—make clean:** Fossil fuels, pollutants and toxic materials are replaced with regenerative sources, thereby increasing and maintaining value in natural ecosystems. In practice: Regenerative and non-toxic material use, renewable energy, regenerative agriculture and aquaculture.
- **Cycle flows—use again:** The reuse of materials or products at end-of-life is optimised, facilitating a circular flow of resources. This is enhanced with improved collection and reprocessing of materials and optimal cascading by creating value in each stage of reuse and recycling. In practice: Design for recyclability (both technical and biological), design for disassembly, recycling.

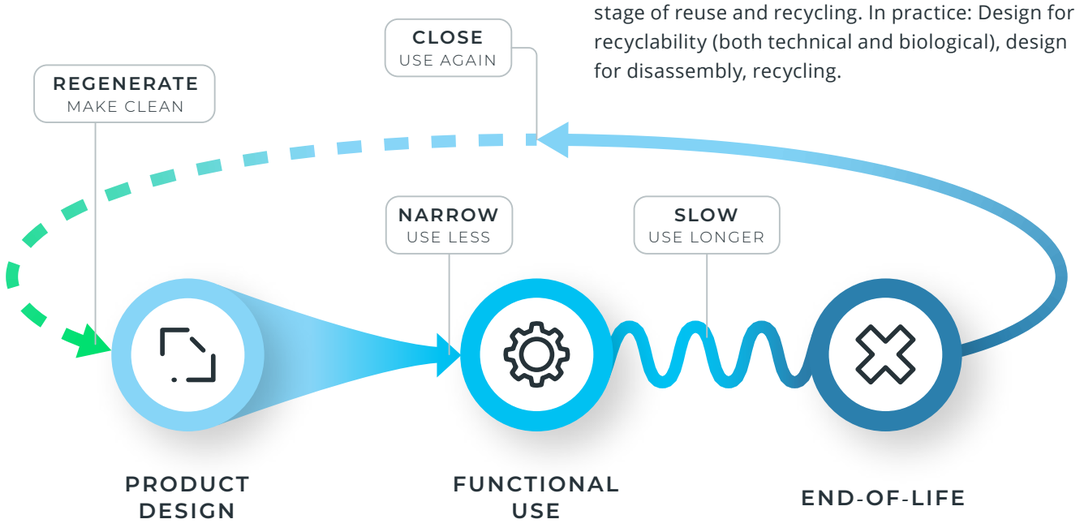


Figure two depicts the four flows to achieve circular objectives: narrow, slow, regenerate and cycle (here labelled 'close').

There are potential overlaps between these strategies: for example, slow and cycle interventions often work together. By harvesting spare parts to use again, we are both cycling—by reusing components—and slowing—by extending the lifetime of the product the components are used for. Ultimately, slowing flows can result in a narrowing of flows: by making products last longer, fewer replacement products will be needed, decreasing material use. The four strategies also present potential tradeoffs. Fewer materials being used for manufacturing—narrow—means less scrap available for cycling. Similarly, if goods like appliances or vehicles are used for longer—slow—their energy efficiency falters in comparison with newer models, preventing narrowing. Using products for a long time decreases the volume of materials available for cycling. This can have a significant impact on material-intensive sectors like the built environment, where having secondary materials readily available is important. What's more, some strategies to narrow flows, like material lightweighting, can decrease product quality and shorten lifetimes—making it more difficult to slow flows.

If we effectively deploy strategies focused on **narrowing, slowing, cycling and regenerating** the flow of materials, we may, ultimately, require a lesser amount and variety of materials to provide for similar needs. Because of this, fewer materials will be used by the economy, they will have a longer lifespan, and they can be reused more effectively and with less harm caused to the environment. For our Circularity Metric to capture this crucial process, we measure the share of cycled materials as part of the total material consumption of an economy. As such, it illustrates the current progress towards achieving the circular economy's ultimate goal of designing out waste through the four listed strategies.

We capture circularity in one number: the Circularity Metric. It is an 'input-focused' metric. Communicated as a percentage, it is a relative indicator of how well global or national economies balance sustaining societal needs and wants with materials that already exist in the economy. The value of this approach is that it allows us to track changes over time, measure progress and engage in uniform goal-setting, as well as benchmark countries' circularity against each other as well as at the global level. It can provide direction as to how Northern Ireland can embrace its circular potential. Since its launch in 2018 at the World Economic Forum, the Circularity Metric has formed a milestone for global discourse on the circular economy.

THE CIRCULAR JOBS METRIC EXPLAINED

The transition to circularity will inevitably result in changes to the labour market, while changes in the labour market will inevitably determine how effective and quick the transition will be. Our Circular Jobs Metric can help policymakers and other stakeholders tap into the employment potential of the circular economy by showing how jobs contribute to realising various circular strategies—and in which sectors these jobs occur.

To estimate circular jobs, we utilise input-output tables, employment data and imported material data to determine how much circular activity is occurring within each economic sector. The Circular Jobs Methodology helps to calculate the share of economic activities, out of the entire sector's transactions, that serve to close material loops, extend product lifetimes and prioritise regenerative resources. The methodology also considers the relationship between enabling and indirectly 'circular' sectors with core 'circular' activities to calculate the share of indirectly circular activities. This helps determine the proportion of employment that takes part in circular activities across the whole economy: eventually translated into a number of circular jobs. For more information, you can read the full methodology document here.

INSIDE THE CIRCULARITY GAP

To accelerate the transition toward a circular economy, we need to use data and data-driven insights in the best way to support top-level decision making. At the same time, given the breadth and scope of systems change towards a more circular economy, local and bottom-up grassroots initiatives are equally crucial to drive changes forward at the community level. To address the complexities and intricacies of a nation's economy, we aim to provide as much information and context on how individual nations can better manage materials to close their Circularity Gap. In our Circularity Metric Indicator Set, we consider 100% of inputs into the economy: circular inputs, non-circular flows and non-renewable inputs, and inputs that add to stocks. This allows us to further refine our approach to closing the Circularity Gap in a particular context and answer more detailed and interesting questions: how much biomass is Northern Ireland extracting domestically, and is it sustainable? How dependent is Northern Ireland on imports to satisfy the basic societal needs of the population? How much material is being added to Northern Ireland's stock like buildings and roads every year? These categories are based on the work of Haas et al. (2020).[26]

Socioeconomic cycling rate (7.9% in Northern Ireland)

This refers to the share of secondary materials in the total consumption of an economy: this is the Circularity Metric. These materials are items that were formerly waste, but now are cycled back into use, including recycled materials from both the technical (such as recycled cement and metals) and biological cycles (such as paper and wood). In Northern Ireland, this number is below, but close to, the global average of 8.6%, totalling 7.9% of total material input. This figure mainly consists of the recovery and recycling of (reported) high-volume mineral construction and demolition waste—which makes up the bulk of it—and biomass, almost entirely animal and mixed food waste. Taken together, both categories contribute to 90% of socioeconomic cycling in Northern Ireland. The remaining 10% consists mostly of high-value, low-mass materials such as metal, glass and paper.

Ecological cycling potential (22.9% in Northern Ireland)

Ecological cycling concerns biomass, such as wood, manure, food crops or agricultural residues. To be considered ecologically cycled, biomass should be wholly sustainable and circular: this means it must, at the very least, guarantee full nutrient cycling—allowing the ecosystem biocapacity to remain the same—and be carbon neutral. Because detailed data on the sustainability of primary biomass is not available, the estimation of the ecological cycling potential needs to rely on a broader approach: if the amount of carbon that comes from land use, land-use change, and forestry (LULUCF) matches the amount of carbon consumed by the economy through primary biomass, then all consumed biomass can be considered carbon-neutral. Northern Ireland's terrain does not provide a setting for significant carbon sequestration, owing to the low share of forested area

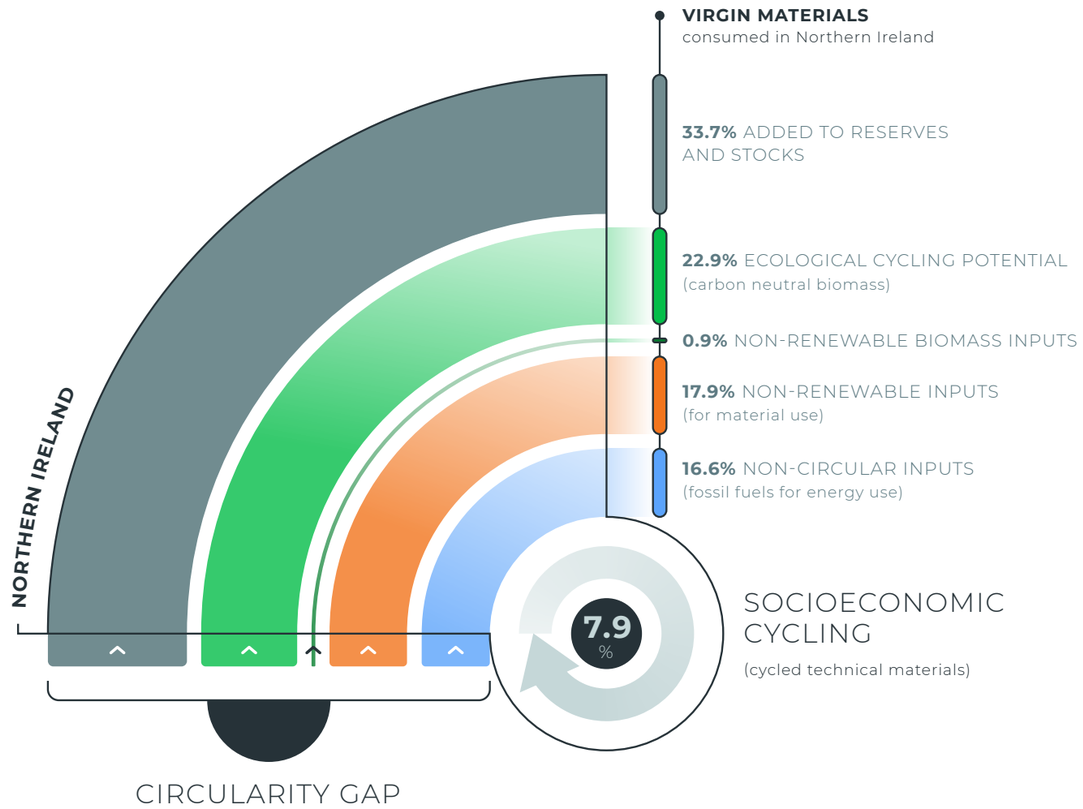


Figure three shows the full picture of circular and non-circular materials that make up Northern Ireland's Circularity Gap.

and land conversion, coupled with the dominance of cropland and extensively managed grasslands for livestock production.[27] The latest UK-wide National Atmospheric Emissions Inventory calculated LULUCF activities in Northern Ireland to be positive[28]—meaning that LULUCF activities in Northern Ireland, mainly agriculture, act as a greenhouse gas (GHG) source rather than sink. Moreover, according to the Committee on Climate Change, GHG emissions from LULUCF have increased by 32% between 1990 and 2016.[29] Therefore, biomass production in Northern Ireland is far from carbon-neutral and, thus, cannot be considered 'circular'.carbon loop closure. For Northern Ireland, this figure represents slightly under 1% of the total material footprint. This can be attributed to LULUCF being a net GHG emitter rather than a sink due to the intensive agricultural production model, particularly for livestock farming, within Northern Ireland, as well as the general lack of more sustainable agricultural and forestry practices across the country.

WHY DON'T WE INCLUDE ECOLOGICAL CYCLING POTENTIAL IN THE CIRCULARITY METRIC?

While carbon neutrality is a necessary condition for biomass to be considered sustainable, it is not the only condition. Nutrients (including both mineral and organic fertilisers) must be fully circular as well. As of yet, we have methodological limitations in determining nutrient cycling: we cannot track where Northern Ireland's food exports end up around the world, or how they are managed at end-of-life. To this end, we have not included ecological cycling in our calculation of Northern Ireland's Circularity Metric—even though this could potentially boost the country's circularity rate to an impressive 40.9%. We take a precautionary stance with its exclusion, with the knowledge that its impact on the Metric may not be fully accurate. We cannot track biomass extracted in Northern Ireland to its final end-of-life stage, so it's difficult to ensure that the nutrient cycle has closed. If this were the case, however—and the sustainable management of biomass becomes the norm—circularity could greatly increase.

Non-renewable biomass inputs (0.9% in Northern Ireland)

This metric indicates a biomass rate that is not carbon neutral. As long as LULUCF emissions are positive (peat extraction not accounted for), a share of biomass will not be carbon-neutral because not all CO_2 will be 'sequestered' through consumption (CO_2 embedded in biomass in Domestic Material Consumption). It is a 'system-wide' indication of the share of non-renewable biomass based on an approximation of biogenic carbon loop closure. For Northern Ireland, this figure represents slightly under 1% of the total material footprint. This can be attributed to LULUCF being a net GHG emitter rather than a sink due to the intensive agricultural production model, particularly for livestock farming, within Northern Ireland, as well as the general lack of more sustainable agricultural and forestry practices across the country.

Non-circular flows (16.6% in Northern Ireland)

This category centres on fossil fuels for energy use. Fossil-based energy carriers, such as gasoline, diesel and natural gas that are burned for energy purposes and emitted into the atmosphere as GHGs, are inherently non-circular. They combust and disperse as emissions in our atmosphere: circular economy strategies are not applicable here, as the loop cannot be closed on fossil fuels. At 17%, Northern Ireland's rate of non-circular inputs is relatively high, suggesting a still rather fossil-fuels dependent character of Northern Ireland's economy, especially sectors such as transport and heating.

Non-renewable inputs (17.9% in Northern Ireland)

Non-renewable inputs into the economy—that are neither fossil fuels nor non-cyclable ecological materials—include materials that we use to satisfy our lifestyles such as the metals, plastics and glass embodied in consumer products. These are materials that potentially *can* be cycled, but are not. Northern Ireland's non-renewable input rate stands at a relatively high 17.9%, suggesting that there is ample room for the improved cycling of non-renewable materials such as metals, glass, plastics and packaging, textiles, and electronics.

Net additions to stock (33.7% in Northern Ireland)

The vast majority of materials that are 'added' to the reserves of an economy are 'net additions to stock'. Countries are continually investing in new buildings and infrastructure, such as to provide Housing, as well for renewable energy, such as building wind turbines. This stock build-up is not inherently bad; many countries need to invest to ensure that the local populations have access to basic services, as well as buildup infrastructure globally to support renewable energy generation, distribution and storage capacity. These resources do, however, remain locked away and not available for cycling, and therefore weigh down the Circularity Metric. At nearly 34%, Net additions to stock in Northern Ireland are relatively high, suggesting high growth of the building stock (residential, commercial and infrastructure). This can be explained by a steadily growing population, the decrease in the average size of households in recent years and the need to upgrade infrastructure.

IF CONTINUED STOCK BUILD UP IS INEVITABLE—SHOULD IT BE CONSIDERED PART OF THE 'GAP'?

Stock build-up will continue to be necessary as Northern Ireland's population grows. However, the rate of stock build-up is also relatively large due to a range of interlinked social, cultural and demographic factors. But the country's high stocking rate may not be inherently problematic, especially if circularity is afforded attention in the design, use and end-of-life phases. For this reason, it may be argued that Net additions to stocks should not be considered part of the Circularity Gap. If all the materials locked into stock were not considered as part of the full indicator set, the Circularity Metric would increase substantially. So why don't we do this?

The Circularity Metric is ultimately a measure of what is cycled—not just what is circular—and materials added to stock can't be cycled for many years, potentially decades, if not more. What's more, the circularity of materials added to stock cannot be ensured: it is not always clear which portion of these materials are designed and used with cycling in mind or to what extent they are regenerative and non-toxic, for example. The bottom line is that: the built environment consumes a huge volume of resources: its impact on Northern Ireland's overall consumption should not be ignored, especially given crucial resource depletion concerns.

A COMPLEX UNDERTAKING: SCOPING AND TRADE DYNAMICS

Applying the Circularity Metric to the global economy is relatively simple, largely because there are no exchanges of materials in and outside of planet earth. For countries, however, the dynamics of trade introduce complexities to which we must adapt our metric, resulting in certain methodological choices.[30]

In a bid to generate actionable insights for the economy and consumption on the ground, and to enable comparison between countries, our *Circularity Gap Reports* take a consumption perspective: we consider only the materials that are consumed domestically. However, there are some limitations to our approach: the more 'open' an economy is the more susceptible to the limitations of both the material flow analysis and input-output analysis, the latter in particular. Some of these limitations include difficulties in calculating the import content of exports.

Secondly, most production is driven by the demand of consumers for a certain product or service. In an increasingly globalised world, the chain that connects production to consumption becomes more entangled across regions. Demand-based indicators—applied in this analysis—allow for a re-allocation of environmental stressors from producers to final consumers. This ensures transparency for countries with high import levels and also supports policies aimed at reducing or shifting consumer demand, at helping consumers understand the material implications of their choices. This approach can also help to ensure that costs of, and responsibilities for, resource depletion and material scarcity are allocated to entities and regions based on their roles in driving production processes through consumption.

So, why is it imperative to reduce consumption? Well, impact prevention through the reduction in demand is an important first step before exploring other mitigation options. This is reflected also by environmental management hierarchies (for example, the circular economy waste management hierarchy) wherein the reduction of production and consumption is always the preferred and most effective strategy.

Thirdly, when considering what residents of Northern Ireland consume to satisfy their needs, we must apply a nuanced lens to the direct imports; meaning we work out the full material footprints of the products. To account for the material footprint of raw materials is straightforward, but this is not the case with semi-finished and finished goods. A motor vehicle, for example, may weigh one tonne when imported, but all the materials used to produce and transport it across global value chains can be as much as 3.4 tonnes. To represent actual material footprints in imports and exports, we apply so-called RME coefficients in this study. As an open economy with high purchasing power and a large consumption footprint, doing so in the case of Northern Ireland is more complex than for a smaller economy.

Finally, the Circularity Metric considers all secondary materials as adding to a country's level of circularity. These secondary materials can include those generated and cycled within the country itself, as well secondary materials that are imported or exported. However, estimating the shares of traded secondary materials is a difficult undertaking, so we introduce an important assumption: in order to estimate the volume of secondary materials imported, we apply the average Global Circularity Index (GCI)—calculated per resource group—to the net direct imports of the country (aggregated by resource group). Because the GCI includes waste for recycling and partially also secondary materials, we assume that this is a good proxy for the estimation of the total amount of secondary materials in the system. The underlying assumption is that—although varying in terms of volume—imports of every country have the same average share of secondary materials per resource group. To determine which share of secondary materials are consumed domestically, rather than exported, we make a second assumption: that the share of secondary materials in the total consumption of raw materials is equal to the share of imported and domestically cycled secondary materials in the total input of raw materials.[31]

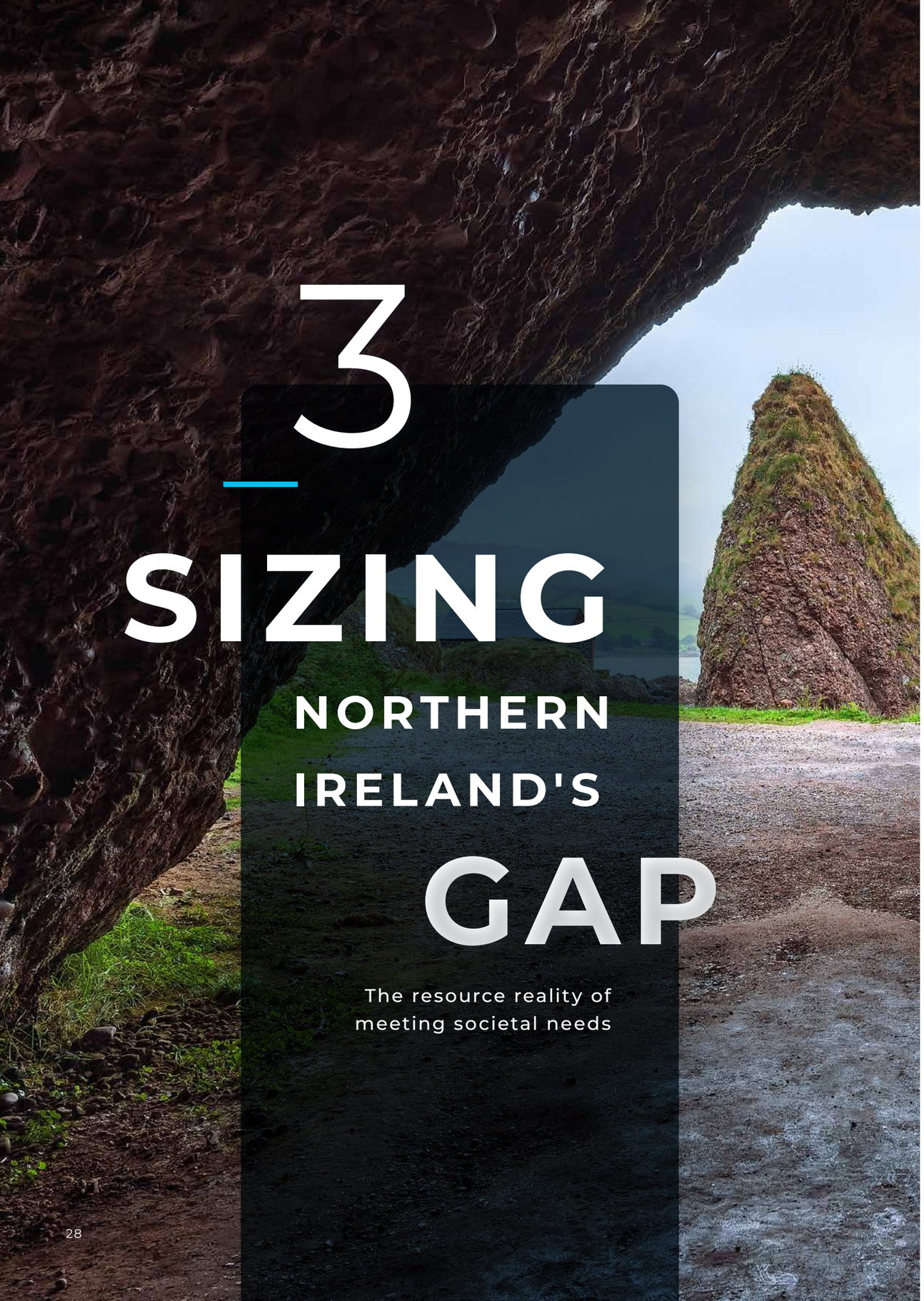
For a more exhaustive look into the methodology behind the Circularity Gap, you can visit our website:

circularity-gap.world/methodology

PRACTICAL CHALLENGES IN QUANTIFYING CIRCULARITY

Providing a year-zero baseline measurement of the circularity of a national economy based on resource flows offers many advantages, not least that it can be used as a call to action. But the circular economy is full of intricacies, and therefore, simplifications are necessary, which result in limitations that must be considered. Some detail needs to be shed for the benefit of having an updated and relevant figure of circularity to guide future legislative action.

- **There is more to circularity than cycling.** A circular economy strives to keep materials in use and retain value at the highest level possible while decreasing material consumption. The cycling of materials measured in the Circularity Metric is only one component of circularity.
- **The Metric doesn't capture all aspects of sustainability.** Our Circularity Metric focuses only on material use: the share of cycled materials in the total material input. It does not account for other crucial aspects of sustainability, such as impacts on biodiversity, pollution, toxicity, and so on.
- **Lack of consistency in data quality.** Whilst data on material extraction and use are relatively robust, data on the end-of-use stage can often be weak, presenting challenges in quantifying material flows and stocks.
- **Quality loss and material degradation.** The Metric focuses on the end-of-use cycling of materials that re-enter the economic system but does not consider in what composition, or to what level of quality. As such, any quality loss and degradation in processing goes unconsidered.
- **Relative compared to absolute numbers.** The Circularity Metric considers the relative proportion of cycled materials as a share of the total material input: as long as the amount of cycled materials increases relative to the extraction of new materials, we see the statistic improving, despite the fact that more virgin materials are being extracted—which goes against the primary objective of a circular economy.



3

SIZING NORTHERN IRELAND'S GAP

The resource reality of meeting societal needs

Northern Ireland is 7.9% circular: the vast majority of materials flowing through its economy come from virgin sources. This chapter dives into the country's socioeconomic metabolism, exploring how materials are used—and at which proportions—to meet various societal needs and wants. Our analysis reveals Northern Ireland's material footprint is typical of other Western European countries at 31 million tonnes. This amounts to 16.6 tonnes per person per year, almost 50% more than the global average of 11.9 tonnes per person per year. Let's put this into perspective: our world's average material consumption already far exceeds levels considered 'safe', and we're rapidly surpassing ecological limits. Key themes have emerged that paint a picture of the country's resource use: Northern Ireland is marked by considerable extraction per capita and prospering trade, with material- and emissions-intensive activities in the quarrying, agrifood and construction sectors. These observations provide a clear starting point, so we can better understand where sectors and supply chains should focus their strategies as they move toward a circular economy.

GLOBAL CIRCULARITY: FROM BAD TO WORSE

Circle Economy's global *Circularity Gap Report 2020* identified that, for the first time in history, our economy is consuming more than 100 billion tonnes of materials every year. But as global resource use has reached new heights, the Circularity Metric has wilted from its 2018 rate of 9.1% to 8.6% in 2020. The reasons for this are threefold: high rates of virgin material extraction, ongoing stock build-up to feed a ballooning population and low levels of end-of-use processing and cycling. The most recent iteration of our *Circularity Gap Report* illustrates the extent of our resource use: in the six years between Paris and Glasgow, we consumed close to half a trillion tonnes of materials, causing emissions to spiral upwards.

The consumption of resources varies across continents and geographies, however. We see that Northern Ireland is the exemplification of the *Shift* country profile—alongside most other high-income countries in the global North (see text box). This means that it scores very highly on the United Nations' Human Development Index (HDI), between 0.8 and 1, but its Ecological Footprint—an indicator that accounts for human demand for biological sources—reflects its mammoth level of consumption. If everyone on earth were to live like the average UK citizen we would require the resources of almost 4.1 planets.[32]

In this way, the classic profile of a *Shift* country is one of high impact: these countries produce 66% of gross domestic product (GDP), while having only 20% of the global population. They also consume the largest share of materials globally and are major world-traders. The pressure is on them to shift away from overconsumption of the planet's resources in servicing their relatively affluent, comfortable lifestyles. Their role in terms of global circularity is also prominent—the true impact of *Shift* countries extends far beyond their national borders, with many environmental and social costs incurred elsewhere. Northern Ireland is a classic *Shift* country: as a high-income economy, it consumes more materials and energy per capita than most of the world's countries in fulfilling its residents' needs and wants.

NOT THE SAME, BUT SIMILAR: DIFFERENT COUNTRIES, COMMON NEEDS

Despite clear divergences between countries, suitable circular economy strategies can be developed based on discernible common needs. Based on the two dimensions of Social Progress—indicated by an HDI score—and Ecological Footprint, countries fall into three broad profiles:

Build—A low rate of material consumption per capita means Build countries currently transgress few planetary boundaries, if any at all. But they are struggling to meet all basic needs, including HDI indicators such as education and healthcare. Country examples: India, Bangladesh, Ethiopia.

Grow—These countries are manufacturing hubs, hosting an expanding industrial sector and leading the way when it comes to building. This rapid industrialisation, and a growing middle class, have occurred concurrently with rising living standards. Country examples: China, Brazil, Mexico, Egypt.

Shift—Home to a minority of the global population, material consumption in *Shift* countries is tenfold that of Build countries. Fossil fuel extraction is relatively high, as is participation in global trade. So despite high HDI scores, these countries have a ways to go in cutting consumption. Country examples: USA, EU Member States, Japan, Argentina.

SOCIETAL NEEDS & WANTS

HOUSING AND INFRASTRUCTURE

The biggest category in terms of resource use is Housing & Infrastructure. The construction and maintenance of the built environment accounts for 11.6 million tonnes (35%) of Northern Ireland's total material consumption.

NUTRITION

Agricultural products such as crops and livestock require 8.2 million tonnes (24%) per year. Food products have short life cycles in our economy, being consumed quickly after production.

MOBILITY

A considerable share of total material consumption is taken up by Northern Ireland's need for mobility: 3.7 million tonnes (11%) per year. In particular, two resource types are used: the materials used to build transport technologies and vehicles like cars, trains and aeroplanes; plus, predominantly, the fossil fuels used to power them.

MANUFACTURED GOODS

Consumables are a diverse and complex group of products—such as refrigerators, clothing, cleaning agents, personal-care products and paints—that generally have short to medium lifetimes in society. Textiles including clothing also consume many different kinds of resources such as cotton, synthetic materials like polyester, dye pigments, and chemicals. They account for 3.1 million tonnes (9.1%) worth of resources.

SERVICES

The delivery of services to society ranges from education and public services, to commercial services like banking and insurance. The related share of total material consumption is the third largest, 3.8 million tonnes (11%) per year in total, and typically involves the use of professional equipment, office furniture, computers and other infrastructure.

HEALTHCARE

With an expanding, ageing and, on average, more prosperous population, healthcare services are increasing globally. Buildings aside, typical resource groups include the use of capital equipment such as X-ray machines, pharmaceuticals, hospital outfittings (beds), disposables and homecare equipment. This accounts for 2.6 million tonnes (7.6%) in Northern Ireland per year.

COMMUNICATION

Communication is becoming an ever more important aspect of today's society, provided by a mix of equipment and technology ranging from personal mobile devices to data centres. Increased connectivity is also an enabler of the circular economy, where digitisation can make physical products obsolete, or enable far better use of existing assets, including consumables, building stock or infrastructure. Total material consumption in this group is less intense, standing at 0.6 million tonnes (1.8%) per year.

THE MATERIAL FOOTPRINT SATISFYING SOCIETAL NEEDS IN NORTHERN IRELAND

Domestic extraction

The Figure on the next page builds on the schematic material footprint diagram in Figure one on page 20. It dives into the socioeconomic metabolism of Northern Ireland; linking how four resource groups (minerals, metal ores, fossil fuels and biomass) satisfy the seven key societal needs and wants shown on page 30. From left to right, the figure shows the domestic extraction of resources (Take) which amounts to **27.3 million tonnes**, mainly through the production of agricultural crops and the mining of non-metallic minerals. These extraction processes result in raw materials like food, stone or sand. However, in a national context, domestic extraction represents only one of the inputs to the economy, which also includes directly imported products, weighing up at 10.2 million tonnes. Re-exports—products that are imported and without any processing are exported again—likely do not make up a significant part of Northern Ireland's imports and therefore are not explicitly quantified in this study.

Material footprint

Considering not just the direct imports, but also the Raw Material Equivalents (RMEs), as previously introduced on page 19, we see that Northern Ireland imports 11.3 million tonnes of RMEs for a total import footprint of **21.5 million tonnes**. This means that Northern Ireland's import footprint is, in reality, almost double the physical weight of its imports. The virgin materials typically undergo processing (Process), for example in the production of metals from ores, cement from limestone, or refined sugar from beets. Subsequently, these refined materials can be used for the manufacturing (Produce) and assembly of products like automobiles from metals, plastics and glass, or the construction of roads and houses. These finished products can, in turn, be distributed and delivered to provide services (Provide) and access to products that can satisfy societal needs and wants locally, or be exported. In 2017, Northern Ireland exported some 6.5 million tonnes of final products with an associated RME of 11.3 million tonnes, resulting in an absolute export footprint of **17.8 million tonnes**.

Waste generation

Knowing what happens to products and materials after their functional use in our economy (End-of-use) is essential for identifying and addressing opportunities for a more circular economy. This is strongly tied to Northern Ireland's material footprint—or virgin material consumption—of **31 million tonnes**. Factoring in its 2.6 million tonnes of secondary material use, Northern Ireland exhibits a total material consumption of **33.6 million tonnes**. The lion's share of total material consumption can be attributed to two societal needs: Housing & Infrastructure—with 11.6 million tonnes (34% of the total material footprint)—and Nutrition, with 8.2 million tonnes (24%). The remainder is distributed fairly evenly between the rest of societal needs, except for Communications.
The total amount of physical waste generated amounts to **11.5 million tonnes,**[33] out of a total 20.2 million tonnes of Domestic Processed Output—the remainder of which comprises emissions, gases and dissipative flows. Of the total, 9.3 million tonnes comes from Products that Last and 2.2 million tonnes from short-lived Products that Flow.

Waste management

While Northern Ireland's waste management system is adept at handling small volume, high-value waste streams (metals, for example), the treatment of high volume, low-value waste (mineral waste, for example) is less than ideal: much of this waste is landfilled. Of the total **11.5 million tonnes** of waste being treated, 27% is 'technically' recycled,34 while the remainder remains unutilised. Of the latter, 1.5% ends up incinerated (including energy recovery) while another 12.6% is landfilled. Remarkably, if unreported waste is not accounted for, the amount of physical waste generated goes down to **4.7 million tonnes** and the recycling rate jumps up to 66%. About 27% of the waste that gets recycled in Northern Ireland belongs to waste streams that either do not fall within economy-wide material flow accounts (EW-MFA) system boundaries (i.e. sludges and liquid wastes from waste treatment, soils and dredging spoils) or do not fall under the definition of socioeconomic cycling (id est, animal faeces, urine and manure). These differences in systems boundaries and in the nature of the indicators explain the gap between the 'technical' cycling (28%) as calculated in this report (and feeding into the socio-economic cycling indicator) and the traditional recycling rate obtained from traditional waste statistics (64%).

Without considering potential unreported waste—and looking at more conventional waste statistics—Northern Ireland has high recycling rates for mineral and solidified wastes (65% to 73%); good recycling rates for chemical and medical wastes (50% to 60%) and for recyclables (62%); and a very low recycling rate for mixed ordinary waste (13%). According to official statistics, there is almost a 100% recycling rate of vegetal and food waste—but we do not consider these figures realistic: losses during transport and the recycling process itself are common and it's likely that some vegetal and food waste is improperly sorted to begin with.

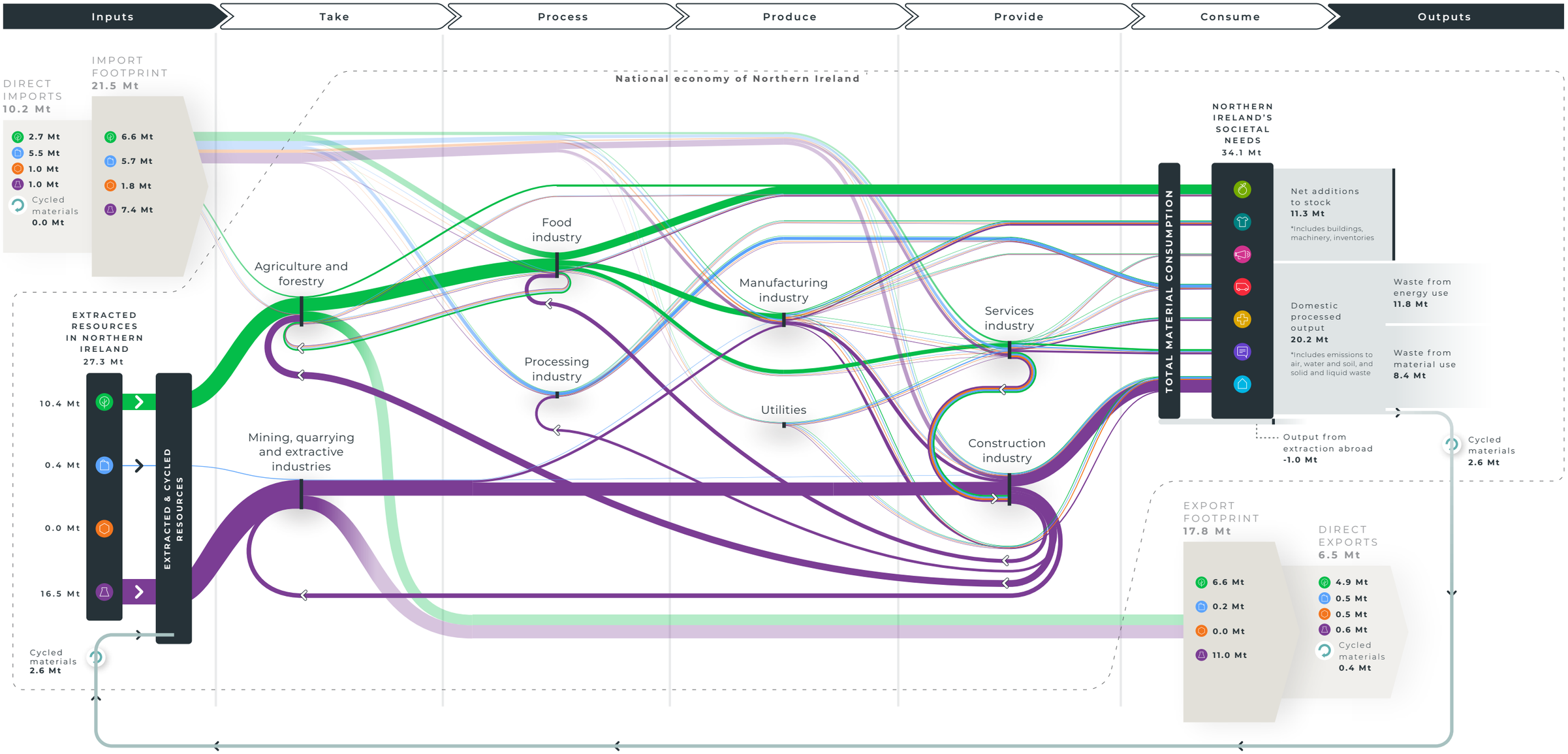
Aside from materials going to waste, **11.3 million tonnes** of materials are added to stock (Net additions to stocks) in the form of capital investments such as buildings and infrastructure, machinery and equipment. Another **11.7 million tonnes** are released or dispersed into the environment, of which 5.5 million tonnes are of fossil origin and 6.2 of biogenic origin: together, these constitute the Domestic Processed Output from energy use. A portion of these (3.8 million tonnes) are dispersed into the environment as a deliberate or unavoidable consequence of product use. This includes fertilisers and manure spread on fields, or salt, for example. Along with 8.4 million tonnes of Domestic Processed Output from material use (end-of-life waste, excluding recycled materials), this amounts to a total Domestic Processed Output of 20.2 million tonnes.

HIGH DEGREE OF UNCERTAINTY FOR WASTE FIGURES

When all waste flows are taken into account from an EW-MFA system boundary perspective,[35] Northern Ireland is underpinned by a great degree of uncertainty: its recycling rate can range from as high as 64% to as low as 28%. This uncertainty stems from the considerable potential for unreported waste that our analysis suggests may exist. This degree of uncertainty has a large impact on waste figures and is particularly problematic. There may be big differences in the figures due to recalculating waste flows according to other system boundaries. Unfortunately, this means that there is no room for making 'educated guesses' because of the high degree of uncertainty surrounding these figures. However, the new development of a digital waste tracking system at the UK-level—led locally by DAERA—is a step in the right direction. The initiative notes that waste data must be collected and collated centrally to have a comprehensive understanding of what happens to goods at end-of-life—therefore enabling circular economy action. Digital waste tracking will make it far easier for waste companies and authorities to meet reporting requirements—while making illegal activities like fly-tipping, deliberate misclassification of waste, illegal waste exports and the operation of illegal waste sites more difficult.[36]

X-RAY OF NORTHERN IRELAND'S ECONOMY

Figure four shows an X-Ray of Northern Ireland's economy: the resources that feed into meeting key societal needs.



RESOURCES 27.3 Mt

BIOMASS	FOSSIL FUELS	ORES	MINERALS	CYCLED MATERIALS

SOCIETAL NEEDS 33.6 Mt

NUTRITION	MANUFACTURED GOODS	COMMUNICATION	MOBILITY	HEALTHCARE	SERVICES	HOUSING AND INFRASTRUCTURE
8.2 Mt	3.1 Mt	0.6 Mt	3.7 Mt	2.6 Mt	3.8 Mt	11.6 Mt

Mismatches between inputs and outputs at the sector level are due to a cut-off for small flows set at 0.5 Mt in order to preserve image clarity.

RELATIVELY MODERATE MATERIAL AND CARBON FOOTPRINT

Northern Ireland is highly dependent on fossil fuels and exhibits moderately high consumption of materials. While the country has taken steps towards decarbonising its economy—with renewables making up almost half of its electricity consumption in 2020 and 2021—this is only part of the picture.[37] Northern Ireland still relies heavily on fossil fuels to maintain industry, heat homes and power transportation. The consumption of fossil fuels is also inherently linked to moderately high material consumption, which also stems from the use of other natural resources such as minerals, metal ores and biomass. Northern Ireland consumes 31 million tonnes of these virgin materials on a yearly basis: an average of 16.6 tonnes for each resident—relatively typical for a high-income economy,[38] and not far from the UK average of 18.4 tonnes per capita.[39] While material consumption is lower than in some other Western European countries—the Nordics, for example—it still soars above the global average of 11.9 tonnes per person per year. However, consumption is generally proportional to size: Northern Ireland houses 0.025% of the world's population and represents 0.03% of the global material footprint.

Northern Ireland's moderate material footprint yields a similar consumption-based carbon footprint: a total of **23 million tonnes** of GHG emissions (in CO_2 equivalents), the average resident of Northern Ireland accounts for 9.1 tonnes of emissions each year. While this is slightly below the UK average of 10.3 tonnes, it's nearly double the global average, which sits at 5.5 tonnes. Northern Ireland accounts for 0.04% of the global anthropogenic carbon footprint; and as with material consumption, this exceeds its share of the population (0.025%). While the country's total carbon footprint tops 23 million tonnes, it's important to recognise that residents are only directly responsible for 6 million tonnes of this—from heating their homes and travelling from A to B, for example. The remainder arises indirectly from non-residential activities: industrial processes and trade activities, for example. Of these remaining 17 million tonnes, only 39% (or 6.5 million tonnes) originate within Northern Ireland: 17% is embodied in imports from the rest of the UK, and 44% is embodied in imports from abroad. The top culprits for the carbon footprint are: petroleum refining—representing 9.5% of the total—construction, at 9.3%, and health and social work, at 8.4%. These three industries also contribute the most to Northern Ireland's material footprint, although in a slightly different order, exemplifying the strong link between material use and emissions. By advancing circularity—and slashing its material footprint—Northern Ireland cut crucially pare down its carbon footprint.

HIGH LEVELS OF EXTRACTION FOR MINERALS AND BIOMASS, WITH A LARGE TRADE FOOTPRINT

Northern Ireland exhibits moderately high levels of material extraction both domestically and abroad, despite its small size. Yearly, **27.3 million tonnes** of materials are extracted within the country's borders: 16.5 million tonnes of non-metallic minerals (primarily basalt and igneous rock, sandstone, sand, gravel and limestone),[40] 10.4 million tonnes of biomass (crop residues, fodder crops and grazed biomass), and 0.4 million tonnes of fossil fuels (limited to peat). No ores are extracted in Northern Ireland. On a per capita basis, domestic extraction equals 14.6 tonnes per person per year, well above the UK average (5.5 tonnes), and slightly above the rest of the World (12.3 tonnes)—but well below Scotland (22.8 tonnes). Northern Ireland is a fairly extractive part of the UK—mainly in terms of minerals and biomass. There are around 160 mineral extraction sites (such as quarries, mines and sand pits) in Northern Ireland, often located in rural and less economically advantaged areas. Mineral extraction activities generate an economic output of around €700 million (£650 million), approximately 2.75 % of GDP, and directly employ 5,600 people.[41] Extracted minerals are then processed and provide mineral products that mainly feed into the construction sector's supply chain: for example, in the form of concrete, aggregates and stone products. Biomass extraction is also very high—especially in per capita terms—and is export-intensive: Northern Ireland produces enough food to feed fives times its population. This illustrates that Northern Ireland largely carries out these operations to satisfy demand elsewhere. It, therefore, has a lot of agency to change and influence the circularity of the rest of the UK and Europe through its exports, although this will also require demand-side measures.

In addition to domestic extraction, Northern Ireland is also responsible for significant raw material extraction outside of its borders, with more than two-thirds (69%) of its raw materials imported from abroad. The majority of metal ores (58%) and the vast majority of fossil fuels are sourced from outside the UK. Raw materials imported from the rest of the UK account for only 12% of total raw material imports, which are equally distributed across biomass, minerals and fossil fuels. Extraction outside of Northern Ireland represents an absolute import footprint of **21.5 million tonnes**, composed of minerals (7.4 million tonnes), biomass (6.6 million tonnes), fossil fuels (5.7 million tonnes) and metal ores (1.8 million tonnes). With an overall raw material net trade balance of 3.7 million tonnes, Northern Ireland imports more raw materials than it exports. When accounting for both extracted and cycled materials, we find that Northern Ireland is self-sufficient in terms of a little under one-third of its resources. In essence, this means that the ecological footprint of Northern Ireland's exports—accounting for waste generated during mineral extraction, for example—is much higher than their physical weight. Northern Ireland's economic activities have a heavy environmental impact. Also of note is that the country is a net exporter of recyclable waste: it exports 0.4 million tonnes, while importing none. Recyclable waste—that is usually high-value (such as metals and plastics)—is largely exported to become secondary materials elsewhere: this can be attributed to a lack of demand for secondary materials domestically. Creating a strong market for secondary materials within Northern Ireland will be a key action for transitioning to a circular economy.

Of the total extraction in Northern Ireland, around one-third (36%) is used to satisfy its own final demand while the rest is exported. Around 34% of the materials it extracts end up in the UK, while 29% end up abroad—a large portion of which is likely exported to the Republic of Ireland. In total, Northern Ireland exports **6.5 million tonnes** of materials, resulting in an absolute export footprint of **17.8 million tonnes**. The difference between these figures is telling: Northern Ireland's exports have a much larger material footprint than their 'final' physical weight might suggest. Minerals (at 11 million tonnes) and biomass (at 6.6 million tonnes) are responsible for the vast majority of this. From these figures, we can discern the high significance of exports in the economy of Northern Ireland and their high-impact trade footprint.

In terms of GHG emissions, Northern Ireland's total carbon footprint is 16% higher than its territorial carbon footprint (**20.7 million tonnes**)—the emissions produced within its borders: in essence, the country is importing carbon embodied in goods produced abroad. This figure is not excessive when compared with other European nations: Sweden's total carbon footprint, for example, exceeds its territorial emissions by nearly two-thirds. Just under half (45%) of Northern Ireland's territorial emissions stem from domestic consumption (these are the same 6.5 million tonnes mentioned above) while 25% are embodied in exports to the rest of the UK and 30% are embodied in exports to the rest of the world. Northern Ireland could continue to slash its emissions—as well as material—footprint by favouring domestic production, or prioritising the import of secondary over virgin materials. This is characteristic of most *Shift* countries: as an importer of materials, Northern Ireland is an exporter of impacts.[42]

AGRICULTURE AND FOOD PROCESSING DOMINATE THE ECONOMY

Agriculture is a core facet of Northern Ireland's economy—both historically and currently. It is closely linked to the food processing industry, which has been growing over recent decades in tandem with the rise of industrial farming. So, unsurprisingly, the agriculture and food processing industries contribute a large portion of Northern Ireland's total material consumption: **8.2 million tonnes**, or 18%. This can be further split into meat production (6%), processing of cattle meat (5%), cattle farming (4%) and processing of other food products (3%). You may recall that Northern Ireland extracts 10.4 million tonnes of biomass per year—and given the breakdown of the agrifood industry above, it follows that almost all of this is livestock production and animal feed, with only 4% corresponding to wood from the forestry sector. Here, it is worth noting that Northern Ireland imports roughly 3 million tonnes of biomass per year for animal feed to produce food—namely meat and dairy— 80% of which ends up being exported. Importing such huge amounts of biomass for animal feed creates an imbalance in Northern Irelands' agri-food sector; this, in turn, creates nutrient imbalances, for example in phosphorus, that lead to environmental problems such as eutrophication.[43]

Northern Ireland's livestock-intensive agricultural model is a reflection of its climate (cool and wet), soils (heavy clay), and topography (uplands) making many areas less suitable for arable farming and better for growing grass. Hence, farms in Northern Ireland are dominated by animals, rather than produce: 80% of farms produce cattle and sheep, while only 5% are used for crops for human consumption—mainly potatoes and cereals.[44] And what's more: while Northern Ireland's available arable land is limited and is not well-suited for horticulture production, much of cereal produced is actually used for animal feed rather than human consumption. This is highly land-intensive and helps

explain why such a large portion (76%) of the total land in the country is dedicated to agriculture. Northern Ireland's expansive agricultural land far surpasses the EU average of 45% and sits slightly above the Republic of Ireland (64%) and the UK average (72%)—keeping in mind the UK average is likely influenced by Northern Ireland's figure.[45] The country produces far more than it consumes: with a population of 2 million, Northern Ireland is a strong food net exporter in nutrient and trade balance terms. Exports are plentiful, weighing up at 4.9 million tonnes, with more than 70 countries benefiting from Northern Ireland's livestock and crops, and their value tops €3.7 billion (£3.1 billion). Exports are nearly double imports, at 2.7 million tonnes—yet both the export and import footprints weigh up at 6.6 million tonnes.

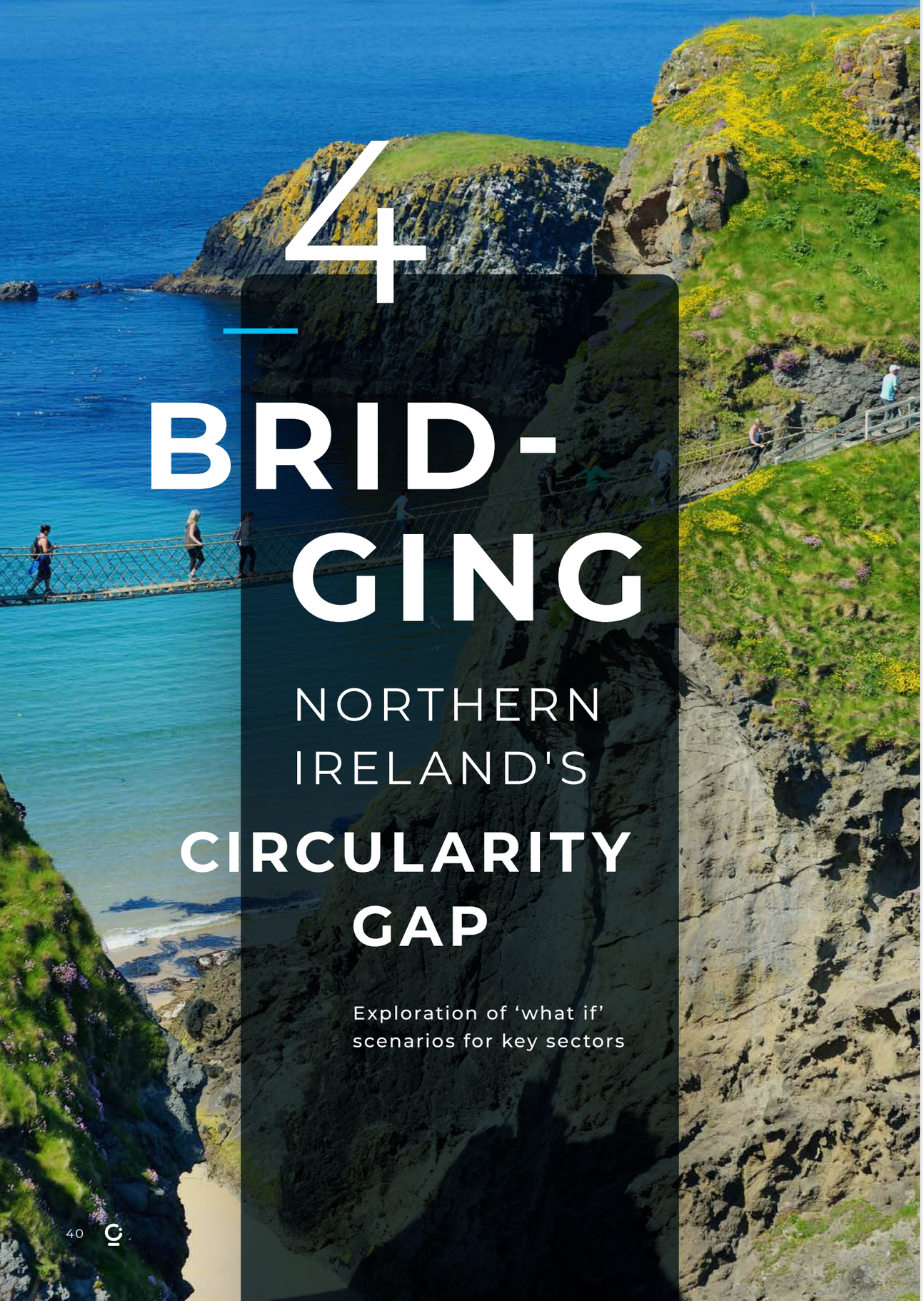
The societal need Nutrition accounts for nearly one-quarter of Northern Ireland's total material consumption: this is almost entirely due to the agriculture industry. Given the tight link between material use and emissions—and especially due to meat and dairy productions' emissions-intensive nature—agriculture accounts for the largest share of Northern Ireland's carbon footprint: 27% of total GHG emissions in 2018, an increase of 0.8% from the previous three decades.[46] While this increase may seem slight, it's worth noting that this is the only of Northern Ireland's most carbon-intensive sectors—agriculture, transport and energy—to increase in absolute emissions since 1990, perhaps due to the increased share of livestock in the country's agricultural profile. Many of these emissions are tied to dairy farms: dairy farming has boasted significant efficiency improvements over recent years, yet these have not been able to make substantial improvements in emissions due to growing production volume. This also means it will be more difficult to decarbonise or, at the very least, to significantly cut the sector's emissions without an overall cut in production.[47] Industrial farming practices—and livestock farming in particular—can also lead to severe water pollution (accounting for one-third of water pollution incidents in 2018), as well as air pollution and biodiversity loss. Fortunately, the processing of agricultural waste has improved over the years: landfilling has decreased by a sharp 45% since 2015, likely due to an increased share of waste used for energy recovery through anaerobic digestion, for example. Nonetheless, Northern Ireland's agricultural sector could achieve a lot by going circular and cutting its high material footprint and emissions profile: this will be further addressed in Chapter four.

A SWELLING BUILDING STOCK TO HOUSE THE POPULATION

Construction is the largest consumer of natural resources in the UK: more than 400 million tonnes of materials are consumed every year.[48] And while Northern Ireland saw a brief period of decline in construction activities up to 2013, the sector is growing once again: housing stock has swelled by 9% between 2008 and 2020. Why? The country's population has grown and is expected to do so by a further 5% by 2040—and households are getting smaller. In 1951, single-occupant households represented just 9% of stock—yet by 2011, this number ballooned to 28%. Single-occupant households mean a less efficient use of materials and have a direct influence on building stock expansion as well as the construction sector's material footprint[49]—as does funding channelled to urban development and infrastructure projects under the *City and Growth Deals*.[50]

Net additions to stock, primarily from the construction and maintenance of buildings and infrastructure, account for **11.3 million tonnes**: a substantial one-third of Northern Ireland's material footprint. The construction sector is highly resource-intensive, using vast quantities of materials, energy and water: satisfying the demand for buildings and infrastructure requires the majority of the total 16.5 million tonnes of non-metallic minerals extracted (such as basalt, limestone, sand and gravel) domestically (60% of total domestic extraction). An additional 1 million tonnes of non-metallic minerals are also imported from abroad, with an associated RME of 7.4 million tonnes: over 86% of the non-metallic minerals embodied in the final goods imported are extracted abroad. This means that even though imported non-metallic mineral products have a relatively low weight (1 million tonnes), their RME is much higher (6.4 million tonnes), meaning that Northern Ireland is externalising the environmental costs of these imported products.

Building stock expansion represents a large portion of the total Net additions to stock (**11.3 million tonnes**) in Northern Ireland. This growth is putting increasing strain on both extraction and imports of construction materials and, subsequently, the total material footprint. It also means that a large amount of Northern Ireland's total material consumption (roughly 30%) is embodied in stock and, thus, not available for cycling back into the economy for decades to come. Of course, this is not inherently bad; but it is crucial that all new construction affords attention to circular design principles, choosing more efficient and less emissions-intensive materials and renovating and retrofitting existing stock where possible. This is discussed in further detail in Chapter four.



4

BRID-GING NORTHERN IRELAND'S CIRCULARITY GAP

Exploration of 'what if' scenarios for key sectors

Now that we have presented how Northern Ireland's Circularity Metric and indicator set are derived and have investigated the message these portray, it's time to analyse the findings and suggest a remedy. First, we identify some of the most impactful sectors of the economy, which we procure based on either a Mass, Carbon or Value level; as well as their potential to reduce the material footprint. For the chosen sectors, we then formulate scenarios that explore and entertain the 'what-if', allowing us to 'dream big' and imagine a more circular Northern Ireland, free from viability and political feasibility. They serve as an exploration of a potential path forward but also sketch which type of sectors and interventions could be most impactful in terms of steering the Circularity Metric and material footprint.

SCORING SECTORS ON THE MASS-CARBON-VALUE NEXUS

We have funnelled our focus for the 'what-if' scenarios into seven key areas that represent key leverage points for Northern Ireland's economy. These scenarios are 1) Nurture a circular food system, 2) Build a circular built environment, 3) Champion circular manufacturing, 4) Power clean mobility, 5) Leverage public procurement, 6) Journey towards sustainable tourism, and 7) Welcome a circular lifestyle. By focusing on a few key sectors, we can dive deep and apply a diagnostic lens to identify where we can best apply interventions to increase the circularity and resource efficiency of Northern Ireland and optimise the transformation of resource use into social benefits.

In selecting our scenarios, we zoomed into the key sectors contributing to Northern Ireland's economy, aligning as much as possible with the eight focus areas (four sectors and four material flows) already prioritised by Northern Ireland's Department for the Economy (DfE). The scenario selection process was also complemented by data on how different sectors score on their material consumption (Mass), greenhouse gas (GHG) emissions (Carbon) and financial value creation (Value): the Mass-Carbon-Value (MCV) nexus.[51] This holistic tool allows us to pinpoint the areas where we can make significant change by introducing circular strategies.

It is also worth noting that in our use of the term sector, we move beyond strict definitions and encompass a range of related areas under one umbrella 'sector'. The repair and recycling economies span across several other sectors and therefore do not score on the MCV nexus. Lastly, due to the different classifications used, the MCV and societal needs differ in their attributions.

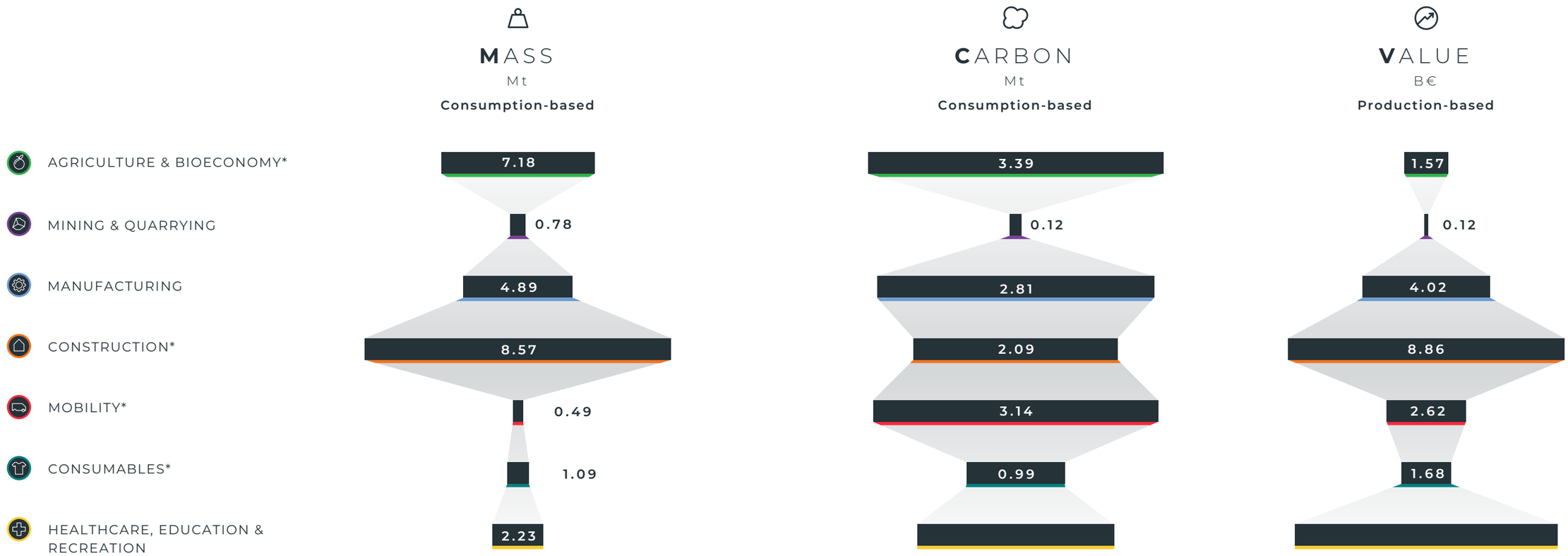
SUMMARISING THE MASS-CARBON-VALUE NEXUS

Firstly, **Mass** is consumption-based, shown in millions of tonnes, and represents the material footprint of each sector. It indicates where the most significant material consumption is taking place in the economy and thus where reducing consumption should be prioritised. Secondly, **Carbon** is consumption-based, shown in million tonnes of CO_2 equivalents (CO_2e), and gives us perspective on where the largest emissions mitigation potential may lie. Thirdly, Value is production-based, shown in billions of euros, and gives us information from an economic perspective. It indicates gross value added (GVA) per activity for each sector.

Before analysing each of these sectors individually, it is also helpful to consider their combined footprint to strengthen our understanding of their magnitude in relation to the rest of Northern Ireland's economy. The mass of these seven sectors amounts to a total of around **25 million tonnes**, accounting for roughly 80% of total material consumption in Northern Ireland. Their carbon footprint amounts to **14.5 million tonnes** of CO_2e, representing about 65% of total GHG emissions in Northern Ireland. Their value amounts to **€27.2 billion**, or about 58% of total GVA. This last point illustrates that Northern Ireland's economy has other important sectors in terms of GVA, for example, service sectors similar to Healthcare and Education such as insurance, financial and IT sectors, that are by nature relatively less material- and carbon- intensive than those discussed below. This is in line with the decline of heavy industry and the expansion of the service sector in Northern Ireland's economy over the last few decades.

Unsurprisingly, the largest material footprint is claimed by the construction sector, representing 8.57 million tonnes, or 27% of the total footprint of Northern Ireland's economy. It is also a carbon-intensive sector, accounting for **2.1 million tonnes** of CO_2e (9% of total GHG emissions), and important in terms of value creation (**€8.9 billion** or around 19% of total GVA). Our second Scenario reflects attempts to reduce this sector's large footprint—and indeed, shows the biggest impact for both cutting material use and boosting the Metric. Agriculture—addressed in the first Scenario—is also a crucial sector: its material and carbon footprints stand at **7.2 million tonnes** (accounting for 23% of the total material footprint) and **3.4 million tonnes** of CO_2e (15% of total GHG emissions), respectively. However, according to our analysis, despite its large environmental footprint, the sector does not contribute greatly in terms of value creation: **€1.6 billion**, or 3.3% of total GVA. Scenario three dives into manufacturing, while Scenario four focuses on emissions-intensive mobility. The fifth and sixth Scenarios, focused on public procurement and tourism, respectively, are closely aligned with the agri-food, construction and mobility sectors. Finally, in line with the previous two, our seventh and last Scenario is closely linked to agri-food and construction, but also to consumables and mobility.

The selection of the scenarios was based on the expert input of local stakeholders[52] and qualitative research. In calculating the total impact of the scenarios on the economy of Northern Ireland, we can only measure the improvement to the Circularity Metric and material footprint, taking a Mass perspective. However, under each scenario, we also report the co-benefits of the circular strategies beyond only a reduction in the material footprint.



*Includes fertiliser

*Includes manufacture of building materials and real estate services

*Includes both freight and passenger transport

*Includes chemicals, plastics, packaging, textiles, furniture small equipment and electronics

Figure five shows the impact of specific sectors on Northern Ireland's economy in terms of Mass, Carbon and Value.

BRIDGING THE CIRCULARITY GAP: 'WHAT IF' SCENARIOS

In the *Circularity Gap Reports*, our scenarios have been largely free from the constraints of law or political realities: deliberately non-time-specific and exploratory, their real-life materialisation did not inform our analysis. Through this approach, we are able to freely imagine what our society could look like with truly transformational change: a close to fully circular economy. What is presented below represents a roadmap that allows us to 'dream big' and sketch which type of interventions and levers are most impactful in terms of driving forward the Circularity Metric, as well as impacting the material footprint.

The selection of the scenarios was based on quantitative and qualitative research, which allowed us to paint a picture of what we're able to model based on methodological limitations. Input from expert stakeholders helped to guide the selection and tailor the scenarios to Northern Ireland's context. In calculating the total impact of the scenarios on Northern Ireland's economy, we can only measure the improvement to the Circularity Metric and material footprint, taking a Mass perspective. However, under each scenario, we also report the co-benefits of the circular strategies beyond only a reduction in the material footprint. Our modelling capacity is continuously evolving and improving: this is reflected by the approach in this report and will continue to improve for future editions. For more information on our scenario modelling, you can refer to our methodology document.

We are aware that measuring the effects of the suggested interventions in terms of their effect on the Circularity Metric and material footprint is a crude simplification which must ignore other relevant aspects such as additional ecological parameters. However, we see the value of this analysis in contributing to the dynamic debate on where to place our bets for enhanced circularity and reduced consumption in Northern Ireland and beyond.

Our scenarios are informed and developed by the ultimate aims of slowing, narrowing, cycling and regenerating resource flows, as described on page 21, which provide a jumping-off point for the strategies needed to spur systemic changes.

1. NURTURE A CIRCULAR FOOD SYSTEM

Worldwide, food is a significant driver of environmental degradation: our food systems contribute one-third of total GHG emissions[53] and require nearly 40% of our world's landmass to grow crops and animal feed, and graze livestock.[54] Dietary choices—especially in high-income *Shift* countries like Northern Ireland, which are marked by a large appetite for emissions-intensive meat and out-of-season produce that travels long distances—are strongly linked to negative environmental impacts as well as our health.[55] In Northern Ireland, this is particularly relevant: approximately three-quarters of the total land area can be attributed to agriculture—a far greater share than the rest of the UK, the Republic of Ireland, and the EU average. This has a substantial impact on Northern Ireland's landscape, geography, wildlife and biodiversity[56] and contributes the largest portion of GHG emissions, representing more than one-quarter of the total.[57] Farming also contributes significantly to the country's economy: Northern Ireland boasts 26,000 active farms, and farming and food processing activities represent 3.5% of GVA and employ 100,000 residents.[58] However, the number of farmers has reduced by around one-third since the early 1980s—and the gap is widening between small farms and larger, more industrialised ones.[59] In spite of agriculture's strong hold on the country, Northern Ireland has the lowest area farmed organically of all of the UK: just 0.8%, compared to the UK average of 2.8%.[60,61] Intensive farming—a practice characterised by significant environmental damage and social challenges—still receives strong policy support due to restricted decision-making processes.[62] However, the country is well-poised to adapt its agricultural systems in an effort to increase sustainability. The revised *Sustainable Agriculture Land Management Strategy*[63] aims to reconcile farming with environmental and societal concerns, while the recently published *Independent Strategic Review of the Northern Ireland Agri-Food Sector* is exploring the opportunities and challenges faced by the sector. It notes that the sector is in 'a game-changing moment' owing to disruptions from Brexit and the increasingly urgent need to tackle the climate crisis.[64]

In this 'what if' scenario for Northern Ireland's food system, we outline two interventions, focusing on both food production and consumption, for Northern Ireland to boost its circularity while cutting the sector's heavy material footprint.

1.1 ENDORSE A BALANCED DIET

This intervention centres on food consumption: if residents of Northern Ireland were to cut excess food consumption and shift towards a plant-based diet, this would both **regenerate and narrow** flows. It also considers strategies to slash food waste generation by preventing unnecessary food production in the first place (**narrowing** flows) and **cycling** all unavoidable food waste.

As noted, dietary choices have a substantial impact on both health and the natural environment.[65] Consumption of fruits and vegetables in Northern Ireland is the lowest in the UK—while daily meat consumption per capita is the highest.[66] The result: in 2020, nearly two-thirds of adults were either overweight or obese, with more than one-quarter of children falling into the same category.[67] Diet-related diseases cost Northern Ireland around £500 million each year—a figure that has steadily increased over the past decade.[68] Currently, residents of Northern Ireland are less likely to be vegetarian or vegan compared to those in England or Wales[69]—and contrary to trends around Europe, the number of vegans has decreased between 2019 and 2021.[70]

Food waste is similarly problematic: in 2018, the UK's total food waste totalled 9.5 million tonnes, the vast majority (70%) of which stems from households. Of the total, 4.5 million tonnes is edible: this equals a massive 15 billion meals—enough to feed the entire UK population three meals a day for a little under four months.[71] This is a massive drain on finances as well as resources, as British households collectively throw €16.4 billions (£13.8 billion) worth of food in the bin each year—and produce 25 million tonnes of CO_2e in the process.[72] Some initiatives, such as the *UK Food Waste Reduction Roadmap*[73] and the voluntary agreement *Courtauld Commitment 2030*[74] have been launched with the aim of tackling food waste, and the issue seems to be gaining traction in Northern Ireland.[75] However, as of yet, action has been limited to tips and suggestions for households: specific plans and targets have yet to be developed.[76]

In modelling this intervention, we assume that each person consumes no more than around 2,000 calories per day and shifts to a plant-based diet: the decreased consumption of animal products is made up for with equivalent caloric intake of cereals, fruits, vegetables and nuts.[77] Food waste is cut and unavoidable food waste is cycled to the maximum extent possible, by, for example, producing energy. This intervention is the most impactful of them all: by cutting waste and excess consumption and embracing a plant-based lifestyle, Northern Ireland could cut its material footprint by a staggering 16%—bringing it down to 26 million tonnes and boost its Metric by 1.9 percentage points up to 9.8%. To demonstrate the power of eating less meat, we also modelled the impact of shifting to a Mediterranean diet—an 80% reduction in the caloric intake of meat, substituted by fruits and vegetables, cereals and nuts—without reducing waste. In this case, the material footprint could drop by a substantial 9%—and the Metric could grow by 0.7 percentage points. These impacts could be higher: we used UK-wide data for meat consumption, while consumption in Northern Ireland is higher. The adoption of a vegetarian diet alone could result in a 12.4% cut in the material footprint—more than all built environment interventions combined—and could boost the Metric to 8.9%.

1.2 ADOPT SUSTAINABLE FOOD PRODUCTION

While the previous intervention centred on food consumption, this one tackles production. We explore a range of strategies to **regenerate and narrow** flows through organic, seasonal and local food production. Although Northern Ireland's geography and climate make this challenging, we envision a food production system that is as sustainable and low-waste as possible: strategies that work alongside—rather than against—nature and reduce reliance on chemical inputs are crucial.

As noted, agricultural land covers most of Northern Ireland—so moving towards sustainable land management and eschewing intensive farming in favour of low-input, regenerative practices are key for supporting biodiversity and ecosystem services, and minimising waste. The country is well poised to do so: recent policy action aims to make sustainability fundamental to the future of the sector.[78,79] Nonetheless, the prevalence of intensive farming is amplifying already-present environmental burdens: ammonia pollution, for example, is primarily linked to intensive agriculture—livestock farming in particular. This is a significant and growing environmental problem, which also brings harmful health impacts: agricultural ammonia emissions can lead to severe respiratory issues and accounts for the largest portion of the yearly €9.5 billion (£8 billion) in health damages from particulate matter pollution.[80] And while ammonia emissions in the UK as a whole have decreased by 14% in the last two decades, Northern

Ireland's emissions have increased by nearly 7%.[81] Embracing more regenerative farming methods, such as combining organic crop production and grazing, multi-paddock grazing systems, agroforestry and silvopasture, to name a few, can ameliorate this problem, while also improving economic resilience, soil and food quality, enhancing biodiversity, and cutting waste.[82]

For this intervention, we assume that Northern Ireland embraces organic, seasonal and local farming, which would practically translate into a reduced demand for fertiliser, heating fuels (for greenhouses, for example) and transportation services. By embracing these strategies, Northern Ireland could decrease its material footprint by a moderate 0.5%—bringing it to 30.8 million tonnes—and boost its Metric by a small 0.04 percentage points.

Impact on Northern Ireland's circularity:

This scenario's two interventions, in all, could decrease the material footprint by 16.5%—shaving off 5 million tonnes from Northern Ireland's material use. Circularity could increase by 1.9 percentage points, bringing the Metric to 9.9%. Shifting to a more circular food system would also bring numerous co-benefits: a dietary shift to a plant-based diet—where animal products are replaced by healthy alternatives—could have positive impacts on health,[83,84,85] in addition to delivering deep cuts in GHG emissions.[86,87] More sustainable agricultural practices already being explored in the country, such as DAERA's Soil Nutrient Health Scheme,[88] will also serve to improve soil health[89] and protect biodiversity,[90,91] especially in regions where intensive farming is more prevalent.[92]

2. BUILD A CIRCULAR BUILT ENVIRONMENT

The impact of the built environment on a global scale is enormous: almost 40% of all carbon emissions can be attributed to building and construction, including emissions from operation,93 while our societal need for housing consumes 38.8 billion tonnes of materials—more than one-third of the global material footprint.[94] Around 40% of global construction volume is directly linked to residential buildings.[95] It also generates vast amounts of waste which, if no action is taken, are projected to increase significantly worldwide over the next 30 years.[96] In the United Kingdom, construction is the largest consumer of natural resources: more than 400 million tonnes of material every year.[97] The situation in Northern Ireland is no different: it is carbon-and material-intensive and, although there is a lack of robust waste data for this sector, it is safe to estimate that it is responsible for the largest waste generation by weight than all other sectors. Construction is also a major contributor to Northern Ireland's economy, accounting for an estimated 8% of GVA in 2019[98] and directly providing over 35,000 jobs.[99] The sector has been badly hit by the onset of the covid-19 pandemic and a sustained recovery is now threatened by shortages of skilled labour and materials as well as inflation. Ultimately, this means that supply chain disruptions and other difficulties currently being faced—both along a global dimension and as a result of Brexit—present a solid opportunity to ingrain circularity in the sector's core, which will deliver environmental benefits as well as greater economic resilience and competitiveness in the long run.[100]

In this 'what-if' scenario for the built environment, we outline opportunities for Northern Ireland to boost its circularity while cutting the sector's substantial material use.

2.1 OPTIMISE HOUSING STOCK

The built environment consumes vast quantities of materials—so it's unsurprising that targeting building stock expansion will have the largest impact on Northern Ireland's material footprint. This intervention makes the most of strategies that **narrow** material flows and **cycle** materials. Building less means that fewer materials will be demanded by the construction sector—and improving the reuse of building materials (like steel and timber) and components (like doors and window frames) for all new construction will serve to further cut the need for virgin inputs. By implementing deep retrofitting[101] in older residential buildings, we also aim to **slow** flows, while precluding the need for new construction and cutting energy consumption—further **narrowing** flows. While this intervention only targets the residential sector and doesn't consider commercial and industrial buildings or infrastructure, it represents a bold move and could bring substantial impact.

As of April 2021, Northern Ireland's total housing stock comprised 814,000 buildings—a little less than half of the total population, and a 1% increase from the previous year.[102] Currently, demand for housing is quickly outpacing supply.[103] Trends within the country—such as a growing population (especially in rural areas), more people living alone and certain policy initiatives—are driving the rapid expansion of the housing stock. Moreover, housing construction has captured around a quarter of the market share during recent years[104] and is currently the fastest-growing sub-sector,[105] making it an imperative to embed circularity in the core of the sector to cut resource use, emissions and waste. But for change to materialise, forward-looking policies from policymakers are needed: via circular public procurement and a fit for purpose legal and regulatory framework, for example. Similarly, the private sector ought to put sustainability at the heart of its business strategy—for example, by adopting more resource-efficient construction practices such as offsite buildings production. Fostering closer collaboration between stakeholders will also be fundamental to catalysing sustainable, long-term change in a sector characterised by long and complex value chains and low profit margins.

This intervention models the impact of circular strategies that will pay off in the long-term: benefits will be largely felt many decades down the road, and we therefore assess the impact now of changes that may occur in more than 50 years. Due to methodological limitations, it isn't possible to estimate what the gap in meeting the increase in residential housing demand is—it could range from 0% to 27%. To model housing stock regulation, we assume that fewer planning approvals are given out that allow for construction with virgin materials, reducing new construction by 27%. All construction and demolition waste is cycled and used again for new construction. Finally, to make up for the drop in new construction, we assume a large increase in (deep) retrofitting practices for older buildings (between 60 and 75 years old)—and in doing so, vastly improve these buildings' energy efficiency, assuming energy savings equating to those attainable through Passivhaus design.[106] This first intervention is highly significant: it would result in a decrease of 7.7% in Northern Ireland's material footprint, bringing it from 31 million tonnes to 28.6 million tonnes. The Circularity Metric would grow by 1.4 percentage points, from 7.9% to 9.3%. This assumes that the waste category 'other mineral waste' is not considered suitable for recycling—if this were to be recycled, the Metric would jump by 3.5 percentage points to 11.5%.

2.2 CHAMPION A RESOURCE EFFICIENT BUILT ENVIRONMENT

This broad intervention covers a range of strategies in the construction and use phases of buildings to do more with less. Emphasis is placed on increasing the resource efficiency of construction processes—**narrowing** material flows—and improving the efficiency of residential buildings' use phase, also **narrowing** flows.

In Northern Ireland, current construction practices are highly resource-intensive—and generate vast quantities of waste. Much of this waste can be tied to a disregard for resource efficiency early in the design phase: this influences material choices, for example. A lack of detailed planning and procurement—spurring high levels of waste on-site—also contributes.[107] Advancing resource efficiency in construction will also be crucial to supporting a systemic transition to a circular economy—as well as for fighting climate change.[108] Efficiency must also be scaled during buildings' use phase; globally, the heating of buildings accounts for half of final energy consumption and accounts for 40% of CO_2 emissions.[109] In Northern Ireland specifically, most residential heating comes from carbon-intensive sources: more than two-thirds of households rely on oil boilers as the primary heating source, followed by gas. Solid fuels like coal and peat—the 'forgotten fossil fuel'—are still used in some rural areas. What's more, nearly one-quarter of households in Northern Ireland are classified as being in fuel poverty, the highest proportion of any region in the UK,[110] with little done politically to tackle the issue.[111] While the ultimate goal of this intervention is to entirely decarbonise household heating by using heat pumps running on renewable energy, for example, improving buildings' energy efficiency through better insulation should be afforded attention during the design phase or improved during retrofitting.[112]

This intervention assumes an improvement in the efficiency of construction practices through strategies such as lightweighting, increasing the lifetime of bearing elements (by ingraining circularity earlier on in the design phase), reducing on-site losses in construction by one-fifth (for example, by improving planning and procurement), and increasingly using more local construction materials and supply chains. It also assumes that energy consumption in households drops, owing to the use of energy-efficient appliances like washing machines and tumble dryers, as well as the use of smart metres. We also model the impact of lowering room temperatures by 2-degrees. These strategies will cut Northern Ireland's material footprint by 0.9%—bringing it from 31 million tonnes down to 30.7 million tonnes—and will bump the Circularity Metric up 0.1 percentage points, bringing it from 7.9% to 8%. This intervention's small impact on the footprint and Metric can be attributed to rebound effects: lightweight construction, for example, may cut the materials needed for the building itself but may require more costly resource- and energy-intensive assembly and disassembly processes. Still, it's important to consider the synergies between the different interventions of this scenario, as well as the substantial co-benefits discussed at the end of the scenario, ranging from GHG emissions reductions to new employment opportunities.

2.3 INCREASE BUILDING OCCUPANCY

This scenario's final intervention combines an arsenal of strategies to increase the average occupancy in both residential and commercial buildings. This will result in fewer buildings needed, ultimately narrowing material flows. As empty properties tend to remain empty and deteriorate more quickly, increasing occupancy can also help to slow flows and make buildings last longer.

In Northern Ireland, empty or underutilised housing is prevalent—and this poses a problem: resources go to waste and demand for housing stock is spiking, driving up prices and leading to social issues. In 2014, the Department for Communities presented an *Empty Homes Strategy and Action Plan*[113] that aimed to address the issue—yet, according to the 2021 review of the strategy, 'it has had limited success in bringing empty homes back into use'.[114] As of 2021, more than 20,000 homes were officially registered as empty—and many more likely have very low occupancy rates, according to estimates from the 2016 House Condition Survey (NIHE). This represents around 2.4% of the current housing stock—a sharp increase from 2018 figures.

In modelling this intervention, we focus on second houses and holiday lets which, on average, have (seasonal) occupancy that is around one-quarter of regular occupancy. Based on results from the latest OMNIBUS Survey carried out by NISRA on home ownership, we estimated that 5% of all the houses in Northern Ireland are second homes and that their occupancy could be increased by 75% if these were to be fully occupied. Rather than assuming a proportional reduction in the stock of dwellings (since these dwellings would not simply 'disappear'), we modelled the impact of reducing monetary transactions from households to real estate services—in other words, rent—for that share of the residential stock, as rent is assumed to embody the annualised footprint of the constructed dwellings. We also model an increase of 25% in the occupancy of multifunctional and co-housing spaces—the maximum possible—with a proportional decrease in the material footprint of real estate services. Increased residential and commercial occupancy also implies that we can assume a cut in the consumption of electricity and heating fuels. By doing so, Northern Ireland could decrease its material footprint by 2.6%—bringing it from 31 to 30 million tonnes—and could bump its Metric up by 0.2 percentage points, to 8.1%.

Impact on Northern Ireland's circularity:

Implementing these circular strategies would increase the Circularity Metric by 1.6%, bringing it up to 9.6%. Recall that we've taken a precautionary stance with our assumptions in this scenario's first intervention: if we were to consider 'other mineral waste' suitable for construction and demolition waste recycling, the Metric could jump to 11.8%. The material footprint would see a substantial decrease of 10.5%, dropping from 31 million tonnes to 28 million tonnes. Other benefits are plentiful: applying these strategies would generate GHG emissions savings and would likely cut costs and strengthen resilience by reducing foreign dependence and market risks. Increasing retrofitting and renovation in tandem with offering new business models—in other words, offering circular goods and services spanning the entire value chain[115,116]—could also create new jobs. These could be seen in offsite construction, closed-loop cycling for building materials and components, and increased digitalisation of building and material management (for material passports and building information modelling), for example.[117]

Northern Ireland has a rich history when it comes to manufacturing: it is one of the country's traditional industries. Despite the sector's contribution diminishing over recent decades, it's still fundamental: the sector is linked to one-quarter of the country's jobs, accounts for one-third of GVA, two-thirds of exports, and is a crucial driver of productivity growth, foreign direct investment, and research and development expenditure.[118] Advanced manufacturing, materials and engineering (AMME)—which involves specialised, versatile and innovative production methods that are more flexible than traditional manufacturing—is a key high value-added sector for the local economy in particular: it represents 11% of employment (employing over 46,000 highly skilled people), and it is worth approximately 15% of GVA or around 8% of local economic output: €3.8 billion (£3.2 billion).[119,120] Given its importance for exports (80% of sales occurring abroad), R&D and productivity, it has also been specifically identified as a priority action for increasing productivity and ensuring access to key markets in the aftermath of Brexit. Northern Ireland's expertise lies across a range of products and sectors: aerospace and defence, automotive, material handling, renewable energy, consumer products and electronics.[121]

3.1 IMPLEMENT RESOURCE EFFICIENT MANUFACTURING

This scenario's first intervention revolves around improving manufacturing's resource efficiency—both during early stages, where materials are formed, and later stages, where products are created. By improving industrial processes—therefore reducing the need for metal inputs such as steel and aluminium—Northern Ireland can **narrow** flows. Gains in material efficiency, which also **narrow** flows, should be integrated in early stages: cutting yield losses involves making the most of technological advances to get more from less. Further along the value chain—where the steel will be used to make a vehicle or machinery—process improvements will bring similar benefits. A reduction of scrap material—typically generated from standard procedure—would also boost efficiency and reduce the need for virgin material inputs, further **narrowing** flows. Unavoidable scrap is reused, **cycling** flows.

Northern Ireland's manufacturing sector is characterised by traditional manufacturing industries, which focus on the production of goods with high metal content: machinery, equipment and manufacturing engineering, for example. The country has become prominent on the global stage for the manufacture of many niche product categories, from computer hard drives to aircraft parts.[122] It also leads the way in the production of mining and construction processing equipment: 40% of the world's tracked mobile stone crushing and gravel screening equipment are produced in Northern Ireland, for example.[123] Boosting the resource efficiency of these products and processes could therefore have a moderate impact on the country's overall circularity and material footprint. This would also be the case for the development of new business models, focused on servicisation and high-value practices such as repair and remanufacturing, as explored in 3.2 below.

In modelling this intervention, we explore the effect of process improvements on reducing yield losses and diverting scraps: we consider the reduction of metals going from manufacturing industries to recycling, in tandem with an equal reduction in the consumption of both virgin and secondary metals across other sectors. By doing so, Northern Ireland could cut its material footprint by 2.3%—bringing it down to 30.3 million tonnes—and boost its Metric by 0.2 percentage points, increasing it to 8.1%.

3.2 EMPLOY R-STRATEGIES FOR MACHINERY, EQUIPMENT AND VEHICLES

This intervention employs various R-strategies[124]—typically known as reduce, reuse and recycle—for manufacturing machinery, equipment and vehicles. Remanufacturing and refurbishment can both extend product lifetimes, **slowing** flows, while repair and maintenance in combination with upgrade and reuse can preclude the production of new machines or equipment, thereby **narrowing** resource flows. Manufacturing companies in Northern Ireland should also explore circular business models centring on the so-called 'inner loops' of technical cycling: offering reuse,[125] remanufacturing,[126] refurbishment and repair[127] services, for example, preserve product value at the highest extent possible.[128] This could be done by revamping current business models to integrate servitisation for example, through Product-as-a-Service systems that employ pay-per-use mechanisms or services such as repair and maintenance.[129] It may be a challenge for businesses to retain ownership

of their equipment in certain cases—but supporting the activities this will allow for will be crucial for the manufacturing sector's circular transition.

As explained in the previous intervention, Northern Ireland has a significant number of AMME companies highly specialised in areas such as automotive, aerospace, materials handling, composites design and manufacturing, and precision manufacturing. These sub-sectors are already familiar with resource efficiency, have a high R&D intensity and are open to innovation. Similarly, businesses tend to operate within integrated supply chains with strong interdependencies as well as inter-industry linkages. In this sense, there are conditions for close collaboration among stakeholders across the supply chain to develop new business models centred around the R-strategies. At the same time, Northern Ireland has the knowledge needed to advance innovation and increase the sector's productivity: it boasts a number of centres undertaking research, such as the Advanced Manufacturing Innovation Centre. It also has the capacity to embrace sophisticated products and processes to help businesses become more sustainable, resilient and exploit new market opportunities, by developing new service offerings and revenue sources that can transform business models over time.[130]

For this intervention, we assume that the overall volume of machinery sales stays the same, due to the rise in redistribution and resale of products that have been remanufactured or refurbished. Regarding products that have been repaired, maintained, upgraded or reused, we assume that the overall sales volume decreases, due to the extended lifetimes of these products. Strategies were applied uniformly across all product categories, divided as follows: 50% remanufacturing and refurbishment, 25% reuse, 12.5% repair and maintenance, and 12.5% upgrading. By doing so, the material footprint could be cut by 2.3%, bringing it down to 30.3 million tonnes. This intervention's impact on the Circularity Metric would be the same as the previous—bumping it by 0.2 percentage points, up to 8.1%.

Impact on Northern Ireland's circularity:

Scaling resource-efficient manufacturing processes and implementing R-strategies across the sector—creating durable and long-lasting machinery, equipment and vehicles—could decrease Northern Ireland's material footprint by 3.8%, bringing it from 31 million tonnes to 30 million tonnes. The Metric could be bumped up by 0.3 percentage points, bringing it from 7.9% to 8.2%. The impact of these interventions might appear to be modest, however, employing this scenario's strategies could also usher in a wealth of co-benefits: reduced energy consumption and lower emissions from efficiency gains, for example. The widespread adoption of R-strategies could also galvanise private sector involvement in the circular economy—incentivising innovation and diversification while creating new opportunities for business and employment. Businesses that transform their business models, by offering circular goods and services, could also strengthen Northern Ireland's manufacturing position on the global stage by boosting competitiveness and resilience in the long term.

Getting people and products from A to B is one of the world's biggest contributors to emissions and material use: we're largely dependent on cars, trains, ships and planes for day-to-day commuting, freight shipping and travel. The situation in Northern Ireland is no different: transport is one of the country's most carbon-intensive sectors, accounting for approximately one-fifth of total GHG emissions—although this has decreased by nearly one-quarter between 1990 and 2019.[131] As a highly car-dependent society, car ownership is high, with around 80% of the population either owning or having access to a private vehicle. Around two-thirds of all private journeys are taken by car, with more sustainable modes of transport like walking, cycling and public transport making up the remainder. The majority of the population lives in rural or semi-rural areas—and thus many residents are required to travel to urban centres like Belfast on a daily basis. While mobility is high, the average journey length is low, coming in at just under 9 kilometres.[132] Predictably, the covid-19 pandemic has radically impacted mobility: journeys by car were cut dramatically as stay-at-home orders rolled out. Before this, figures have remained stable over the last two decades.[133]

This scenario models the impact of two interventions to cut mobility's hefty material footprint and boost its circularity, by going car-free, prioritising efficient vehicles and electrifying Northern Ireland's vehicle fleet.

4.1 EMBRACE A CAR FREE LIFESTYLE, IMPROVED MODAL SHIFT AND FLEX WORK

This scenario's first intervention entails residents of Northern Ireland embracing a more car-free lifestyle—and continuing to work-from-home where possible. This will reduce the need for private car ownership as well as fuel consumption, both serving to **narrow** flows. Making up for the drop in private mobility with an increased use of public transport will result in a modal shift that also **narrows** flows.

Workers in Northern Ireland tend to live relatively close to their workplaces: on average, commutes are just under 17 kilometres[134]—or around 20 minutes in the car, travelling at a leisurely pace.[135] Stay-at-home ordinances enacted in response to the covid-19 pandemic have already significantly reduced workplace mobility, however: travel restrictions have massively cut down passenger journeys, especially for public transport such as bus and rail.[136] It seems flex work could be here to stay: recent studies illustrate that there is huge untapped potential for current jobs in Northern Ireland to be performed remotely.[137] Prior to 2020, less than 4% of workers worked primarily from home—a figure that has surged to 41%. And while research has shown that many workers welcome a return to the office, most prefer a hybrid arrangement where work-from-home is still on the table for a few days out of the week—with women in particular appreciating the opportunity. It has also been noted that remote working can be viewed as a 'labour market activation tool' to re-engage the economically inactive—such as those that have been unable to work due to child or home care duties.[138]

This intervention models the impact of increased workplace flexibility allowing for more flex work, coupled with the increased use of public transport for long-distance travel and walking and cycling for short-distance travel. We assume that 40% of the urban population—and 10% of the rural population—shift to a car-free lifestyle, where 30% of journeys shift to bike and foot, while the remaining 70% are covered by car sharing. The untapped potential of public transport capacity is also considered: we calculate maximum occupancy so that this intervention's realisation won't require additional investment in public transport vehicles. Finally, to model the impact of shifting to flex work, we assume a 20% reduction across all transport modes—which collectively represent one-third of total travel.[139] By realising these strategies, Northern Ireland could cut its material footprint by 3.1%, bringing it down to 30 million tonnes. This intervention could also boost the Metric by 0.3 percentage points, bumping it up to 8.2%.

4.2 CREATE EFFICIENT VEHICLES AND ELECTRIFY THE FLEET

Our second intervention for mobility encompasses a number of strategies focusing on the production phase, rather than the use phase. By prioritising lightweight, fuel-efficient vehicles—both private cars and vehicles used for public transport—Northern Ireland can cut material and fuel use, therefore **narrowing** resource flows. In the future, new vehicles for public and private transport should be electric: this would also serve to **narrow and regenerate** flows.

This intervention aligns with the UK's *Road to Zero Strategy*,[140] which envisions a fully electric vehicle fleet by 2050, with the sale of new petrol and diesel

cars phased out by 2030. It's already doing relatively well, at least in comparison to the rest of Europe: the UK has the third largest ultra low emission vehicle (ULEV) fleet—yet these vehicles still only represent a little over 1% of the cars on the road.[141] What's more, Northern Ireland has the smallest ULEV fleet of the UK—less than half that of Scotland and England. Within the country, most ULEVs are concentrated in urban centres, with Belfast boasting the largest share.[142] Prevailing attitudes still give preference to petrol vehicles: around three-quarters of respondents to one survey said that the likelihood of purchasing an electric vehicle for their next car would be 'unlikely' (33%) or that they 'wouldn't even consider it' (42%)—and only 2% were definitively convinced that they would do so. Why might this be the case? A lack of publicly available charging infrastructure and high prices are key issues[143]—although some initiatives, such as grants, incentives and investments, are slowly flowing in to alleviate these barriers.[144] For the future, it's crucial that supportive measures don't just target private vehicles—public transport, such as buses, should also be afforded attention. An example of an advancement in this realm is Translink, which runs Belfast bus service, converting one-third of the fleet to zero emissions this year.[145] Green hydrogen can also be a strong driver for clean transport in Northern Ireland, especially in the case of heavier vehicle applications.[146]

In modelling this intervention, we assume design improvements that result in lighter-weight private and public vehicles—resulting in fuel savings—and that half of the car and the entire bus fleet are powered by electric engines. We assume that the demand for transport—expressed in terms of passengers per kilometre—remains constant. By employing these strategies, Northern Ireland could cut its material footprint by a substantial 4.7%, bringing it down to 29.5 million tonnes. Its Circularity Metric would also swell by a little more than 0.4 percentage points, bringing it up to 8.4%.

Impact on Northern Ireland's circularity:

Individually, this scenario's interventions would have a larger impact on the Circularity Metric, boosting it by 0.3 and 0.4 percentage points, respectively. However, when accounting for interactions between different strategies, these two interventions combined would increase the Metric by a total of 0.5 percentage points, bringing it up to 8.4%. Other important benefits (not captured by the Metric) are also worth considering, firstly being that the material footprint would drop substantially, from 31 million tonnes to 29 million tonnes—a reduction of 5.9%. Other benefits would be abundant: from a decrease in energy consumption and GHG emissions[147] as well as improved air quality, to less noise and more room for amenities and green spaces. A flexible, hybrid-mix of work-from-home and office time could also positively influence productivity, health, and well-being as well as bring social benefits. However, potential downsides such as diminished collaboration and social interaction, fair distribution of extra costs by employers and employees must also be considered and addressed.[148]

5. LEVERAGE PUBLIC PROCUREMENT

Globally, the public sector holds huge power to drive sustainability and circularity through procurement: yet these opportunities go largely unfulfilled. In Northern Ireland, the public sector makes up a substantial part of the economy and wields major spending power: procurement accounts for around €3.6 billion (£3 billion) per year, around one-quarter of the Executive's total budget. In 2018—2019, Northern Ireland's 11 councils spent roughly €1.2 billion (£1 billion), with €160 million (£131 million) spent on acquiring or improving new assets. Additionally, €1.5 billion (£1.2 billion) have been committed to City Region and Growth deals.[149] A large portion of spending falls under construction—one of the country's most material and emissions-intensive sectors—and services contracts. Meeting various societal needs consumes vast amounts of materials to construct buildings for public services, from social housing, schools and leisure centres to hospitals, libraries and courts—as does providing food and waste management containers within many of these facilities. If the public sector were to align its spending with circularity, the impact could be huge: contracts for construction works, infrastructure projects and goods and services could all work to minimise material flows and close loops, preventing environmental damage and bringing social benefits to boot.[150] How could this be done? Ingraining eco-labels and standards, life-cycle approaches and performance-based procurement as a core part of procedures as well as investing in training staff to advance circularity.[151] Collaboration will be key, too: procurers must actively engage in market dialogue and cooperate with other stakeholders along supply chains to drive and scale action.[152]

5.1 CAP PUBLIC STOCK EXPANSION & PROCURE FOOD SUSTAINABLY

This Scenario's only intervention comprises two strategies. The first: restrict the expansion of public building stock—**narrowing** flows while also **cycling** materials, and **slowing** flows through the (deep) retrofitting of older (public) buildings. This first strategy is comparable to Scenario 2.2: Champion a resource-efficient built environment. Our second strategy centres on a sustainable food system: all public spending on food for schools, prison canteens and government events will embrace the strategies laid out in our first Scenario: cutting excess food consumption and embracing a plant-based diet to **narrow and regenerate** flows. All publicly procured food that goes to waste will be better managed, too, in an effort to **cycle** flows.

Given that the public sector makes up a sizable portion of Northern Ireland's economy, we assume that a significant portion of the building stock is also publicly owned—and thus can have a substantial impact. Pursuing a sustainable food procurement strategy can be an effective way to encourage changes in food production through strong and stable demand incentives, and to implement widespread dietary changes across a wide spread of the demographic. Given the detrimental health and environmental outcomes of current food consumption described in the first Scenario, Northern Ireland is presented with a huge opportunity to boost its residents' health in tandem with its ecological health. We present some of the ways public procurement could be leveraged as a powerful instrument to maximise the environment, social and economic benefits, but there are others. For instance, the Executive has already mandated that from the 1st of June 2022 'public tenders must allocate a minimum of 10% of the total award criteria to social value' for service and construction contracts above a certain amount.[153] Additionally, the *Investment Strategy for Northern Ireland (ISNI)*[154] includes clear investment criteria—such as a mandatory requirement to use certain percent of secondary materials in public construction projects, and use of contracts that consider whole-life costing and that don't default to lower cost options. These rather incentivise innovation, risk-taking, new business models, and the development of strategic partnerships.[155] Last but not least, investing in the development of circular skills, knowledge, and expertise in departments such as budgeting and tendering is also crucial to fully capitalise on the power of circular public procurement.

In modelling this intervention's first strategy, we assume that the number of planning approvals granted for new public construction projects using virgin materials is cut by 25%. This restriction is applied to 82% of public stock—excluding hospitals—and represents around 16% of Northern Ireland's construction-related investments. We also assume that all construction and demolition waste is cycled for use in new public building projects. To make up for the cut in new construction, we also model the impact of retrofitting older stock. In modelling the second intervention, we apply all the assumptions of Scenario 1.1 to publicly procured food.

Impact on Northern Ireland's circularity:

Public procurement is a powerful tool to cut the material footprint of two of Northern Ireland's most material-intensive sectors: the built environment and the food system. In doing so, the country can slash its material footprint by 3.8%—bringing it down to 30 million tonnes—and boost its Metric by 3 percentage points, up to 11%. As for our first two Scenarios, additional benefits will be manifold: reduced emissions, healthier ecosystems and people, and thriving biodiversity. And because public procurement can drive up demand and steer market engagement, this Scenario would help 'level the playing field' for businesses offering sustainable goods and services—as well as boost innovation and create new business opportunities in the private sector.[156] By setting such an example, the public sector can send a strong signal to the private sector to make the investments needed to facilitate change. If done well—with social concerns front of mind—circular public procurement can also serve to foster social equity and justice.[157]

Material- and emissions-intensive tourism encapsulates a range of activities and sectors, from housing and food to transport, and accounts for a broad range of substantial environmental issues worldwide: erosion, GHG emissions and waste generation, habitat and biodiversity loss and pollution among them.[158] Socially, tourism can also be linked to overcrowding, noise and a sense of dispossession for local communities. As such, the Environmental Audit Committee of the UK Parliament has launched an inquiry into sustainable tourism and is looking at ways to minimise the environmental impacts of the sector.[159] The industry's economic contribution is major, and has grown steadily over the last decade: in 2019, before the onset of the covid-19 pandemic, travel and tourism in the UK economy was valued at an estimated €280 billion (£237 billion) and was linked to over four million jobs.[160] In Northern Ireland, tourism has also grown substantially as an industry over the past decade: in 2019 it was worth around 5% of GDP and directly sustained more than 70,000 jobs.[161] The rise of travel-based holidays led to 5.3 million people visiting Northern Ireland in 2019—and spending a record-breaking €1.2 billion (£1 billion), the largest share from visitors outside the country.[162,163] However, this sharp increase wasn't long lasting; the covid-19 pandemic hit hard, causing visits to plummet, businesses[164] to struggle and jobs to wane.[165]

In this what-if Scenario, we put forward one intervention to change this industry's high material use and emissions profile: local tourism.

6.1 PRIORITISE LOCAL TOURISM

This Scenario's only intervention explores what could happen if residents of Northern Ireland begin to take trips locally rather than abroad. First and foremost, this would **narrow** flows by reducing transport. However, due to the horizontal nature of tourism and its overlap with other sectors—such as food, transport and the built environment—it is difficult to isolate interventions for modelling. For instance, it is not feasible to model an intervention for tourism by tweaking local businesses and infrastructure, because these are used primarily by residents and partially by tourists. It is also worth remembering that our analysis takes a consumption-based approach: this means that the expenditure of tourists in Northern Ireland is allocated to their country of origin, and vice versa. From this, we can assume that tourism can only impact Northern Ireland's footprint by cutting their consumption abroad. Therefore, we present this more 'exploratory' scenario, where we look at the impact of fully shifting to local tourism and expenditures from the residents of Northern Ireland.

In 2019, it was estimated that domestic tourism accounted for 2.3 million overnight trips within the country's border—roughly half of the total—4.8 million nights spent in local accommodation, and €374 million (£313 million) spent within Northern Ireland. To compare, more than 4 million trips were taken by residents of Northern Ireland abroad: a substantial number, which largely contributes to waste and pollution elsewhere.[166]

Our model assumes that residents of Northern Ireland swap out foreign travel in favour of local trips—thus modelling a full reallocation of the spending on certain services abroad to spending on their domestic counterparts. It is also worth noting that many of the interventions presented in this chapter, particularly those related to food and agriculture (Scenario one), the built environment (Scenario two), and mobility (Scenario four) hold the potential to have a direct positive impact on the tourism industry in Northern Ireland. For example, supporting sustainable food production and consumption and cutting food waste (1.2), reducing energy use of buildings (2.2) and maximising occupancy (2.3), and electrifying transport (4.2). At the same time, there are certainly more ways to make tourism more sustainable and minimise its negative environmental impacts: this implies broader changes, some of which are discussed in Chapter six.

Impact on Northern Ireland's circularity:

Unlike other Scenarios, increasing local tourism (while cutting the number of journeys made abroad) would actually have a slight negative effect on both the Metric—decreasing it by 0.03 percentage points—and the material footprint, causing it to swell by 0.3%. There are two main reasons for this: firstly, an additional demand on materials and increased consumption domestically would occur, and secondly, the environmental impact of providing services and goods related to tourism activities (such as food, housing and mobility) in Northern Ireland tends to be higher than elsewhere. However, this Scenario would bring numerous other benefits and should not be overlooked: for example, the cuts in emissions and pollution and increases in well-being espoused by our other Scenarios for the built environment, mobility and food.

Consumption makes the world go round, it seems—but excessive materialism has been found to damage individual well-being alongside the environment. Our current linear model has bred a damaging cycle: consumable goods are manufactured from raw materials, sold, used, and then, largely, are discarded:[167] waste is created without regard for people or planet. This progression hasn't been natural—but influenced largely by both economic models that put profit above all and cultural norms that put ownership and material wealth on a pedestal. While the largest portion of the shift to a circular economy must be undertaken by businesses and governments, we all have a part to play: this scenario explores how a shift towards a more sustainable, community-based lifestyle that embraces sharing over ownership could impact Northern Ireland's Metric and material footprint. Northern Ireland is well-aligned with other Western counterparts in this realm: its society is largely based on consumerism. Regularly purchasing excess new clothes and picking up food laden with plastic packaging on each weekly shop is normal and expected—a huge shift from a few generations before. This has caused individual material footprints and waste generation to spike. Transitioning to circularity will require a better understanding of the relationship between social and material dimensions,[168] as well as a new consciousness of what we're consuming and for how long.

Our final 'what if' Scenario explores the role of consumption in a circular economy[169] and the practicalities of material 'sufficiency' and decreased consumption: in other words, having *enough* but not *too much* stuff. We explore this by analysing consumable goods, such as clothes, healthcare products, food and its packaging, household appliances and furniture, and travel habits. This scenario is all about the individual: what can be done to shift consumption patterns in a way that espouses circularity?

7.1 EMBRACE A 'MATERIAL SUFFICIENCY' LIFESTYLE

This Scenario's only intervention explores the impact of a low-impact lifestyle, which values thrift and frugality over affluence and wastefulness.[170] We propose a range of strategies aimed at minimising consumption, **narrowing** flows, encouraging residents of Northern Ireland to use products for longer, **slowing** flows, as well as using eco-alternatives and recycling as much as

possible to **regenerate** and cycle flows. Cutting the number of consumables in circulation—**narrowing** flows—is the most impactful strategy: the needed shift is one to a lifestyle of 'material sufficiency'.

In Europe, overconsumption is having a massive impact: textiles are the fourth highest pressure category for the use of virgin materials and water, coming after necessities like food, housing and transport—and they rank fifth for GHG emissions.[171,172] These items are often quickly disposed of, and in the UK, much of what's tossed out—around 30%—is either landfilled or incinerated.[173] Electronic waste is also substantial: it is estimated that the UK produced a total of 1.6 million tonnes of electronic waste in 2019, equating to approximately 24 kilograms of waste per person[174]— figures likely set to increase given that the UK has one of the fastest-growing electronic waste streams in the world.[175] The precious metals and critical raw materials present in electronic waste currently being hoarded in UK homes would have an estimated market value of as much as €400 million (£370 million) if they were to be recycled.[176] And what's more—each year the UK is responsible for more than two million metric tonnes of plastic packaging waste: approximately 36 kilograms per person in 2019.[177] In Northern Ireland, over 4 million single-use plastics are dumped every week, over 220 million items a year, most of which end up landfilled or in the ocean.[178] There's a clear opportunity to do better—but this will require strong policy support, investments in advanced infrastructure and technologies, new business models, and new consumption patterns by shifting public perceptions and attitudes, likely necessitating effective public awareness campaigns. Fortunately, this shift is slowly beginning to take place: the Northern Ireland Resources Network, for example, connects community groups, charities and social enterprises across the country to support the growth of reuse and repair organisations, cutting waste in tandem.[179]

For this intervention, we model a range of strategies in combination. The consumption of textiles is reduced, and for new purchases, items with recycled fibres or that are durable and high quality are preferred. How? Consumers should be encouraged to reuse and repurpose their clothes each season rather than discarding old and buying new items—an action with substantial environmental impact that will also positively impact budgets. We also assume that household appliances and furniture are minimal and purchased locally—and where possible, residents buy items with replacement parts available in case of breakage. Single-use plastic items—such as bottled water and shopping bags—are heavily decreased, as is paper use, by printing only what's needed, buying recycled paper and toilet paper, and increasing digitalisation (through e-books, for example). Finally, we assume that exchanges within communities are heightened: people depend more on community members than commercial services (for repair and reuse, for example), and local cultural activities and home-based hobbies like gardening are preferred to long-distance travel.

Impact on Northern Ireland's circularity:

This intervention could cause Northern Ireland's material footprint to drop by a staggering 13.5%—the biggest impact of all the scenarios—bringing it from 31 million tonnes to 27 million tonnes. The Metric would grow by 1.1 percentage points, reaching 9.1%. Other benefits would be abundant: excessive materialism, for example, is associated with lower well-being and depression[180] for which circularity and lower consumption could be the remedy.[181] Reducing overconsumption could also mean that Northern Ireland may enjoy less waste, litter and pollution. In addition, more sustainable, community-based lifestyles could bring a range of social benefits: more inclusive and resilient communities and a heightened sense of belonging among them.

Individual interventions along a range of platforms have a limited impact on the Circularity Metric and the material footprint, but when we combine the interventions we see a substantial impact.

In our broad 'what-if' image for the economy, if we harness the cross-intervention synergies, Northern Ireland's material footprint of consumption is lowered by a remarkable **48%**, from 31 million tonnes to a mere **16 million tonnes**. On a per capita basis, the material footprint could be reduced from 16.6 tonnes to around 8.3 tonnes per year, bringing the figure close to what is considered a sustainable level for European nations.

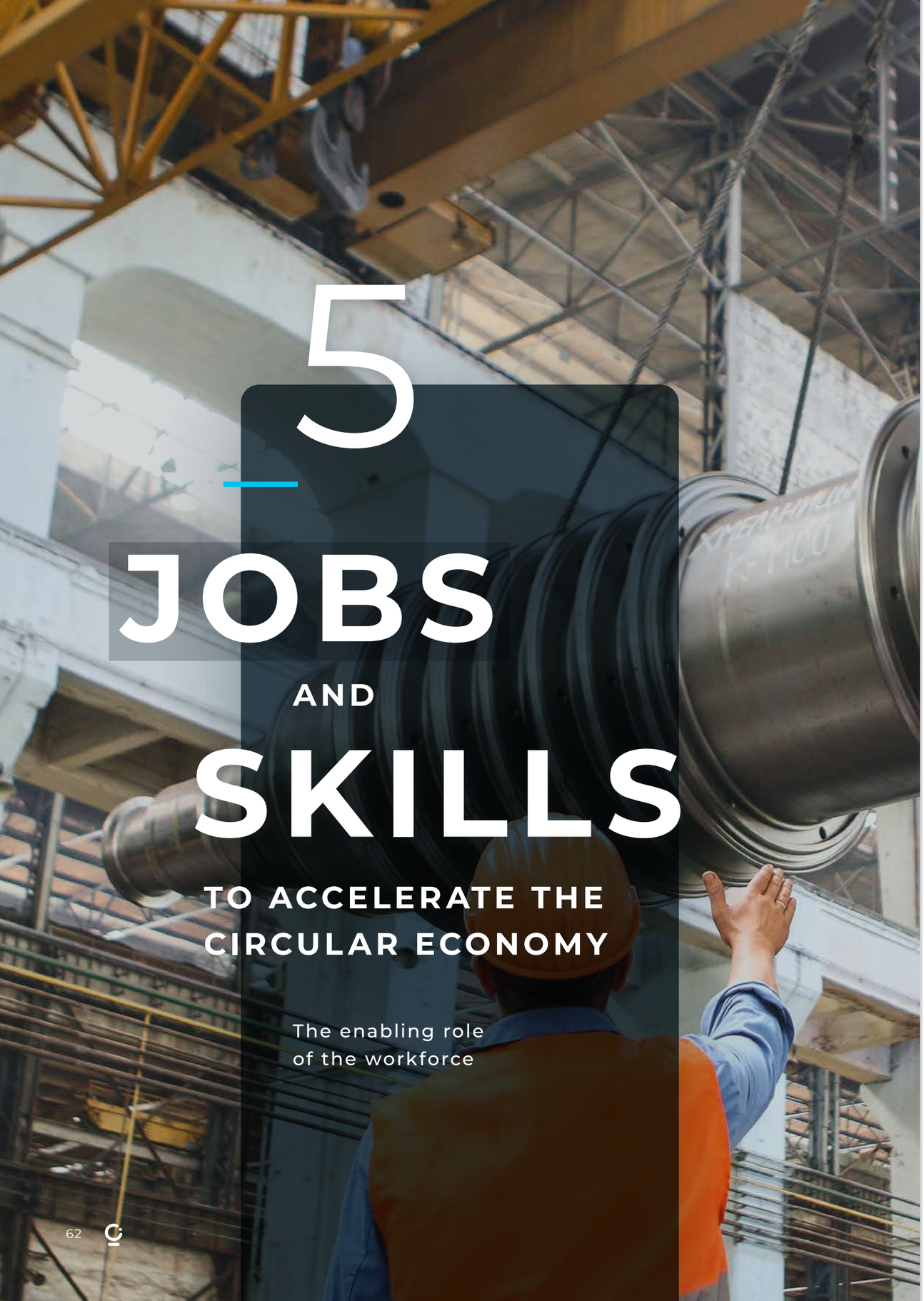
When combining the interventions, it is crucial to be aware of potential overlaps across them. In particular, the scenarios on repair, recycling, as well as fossil resource consumption, are applied across sectors, thereby also influencing the industry specific interventions on agriculture and construction. Therefore, we prioritise interventions according to principles of the circular economy. We begin with strategies that aim to reduce inputs, secondly applying repair and reuse focused scenarios and only lastly applying those focused on recycling.

SCENARIOS, INTERVENTIONS & STRATEGIES

SCENARIOS	INTERVENTIONS	STRATEGIES	IMPACT AND MATERIAL FOOTPRINT
1. NURTURE A CIRCULAR FOOD SYSTEM	**1.1 Endorse a balanced diet**	• Dietary shift towards a plant-based diet • Cut waste generation and maximise food recycling to produce less food	Circularity rises from 7.9% to **9.9%**. Reduction of material footprint by **16.5%**, decrease to **26 million tonnes.** Co-benefits: Health benefits, reduced GHG emissions, increase in biodiversity and soil health.
	1.2 Adopt sustainable food production	• Shift towards organic, seasonal and local food production • Reduced fertiliser use, heating fuels and transportation services	
2. BUILD A CIRCULAR BUILT ENVIRONMENT	**2.1 Optimise housing stock**	• Optimise housing stock expansion • Use secondary materials for new construction • Increase deep retrofitting	Circularity rises from 7.9% to **9.6%** (or to **11.8%**, if other mineral waste is considered suitable for recycling). Reduction of material footprint by **10.5%**, decrease to **28 million tonnes.** Co-benefits: Reduction in GHG emissions, lower energy consumption and waste, increased availability of space for community use or renaturation.
	2.2 Champion a resource efficient built environment	• Use lightweight and durable bearing elements • Reduce losses during construction process • Boost energy-efficient appliances and use • Lower room temperature by 2-degrees and employ smart metres	
	2.3 Increase building occupancy	• Regulatory measures to increase occupancy in second houses and holiday lets • Increase co-housing and multifunctional space incentives	
3. CHAMPION CIRCULAR MANUFACTURING	**3.1 Implement resource efficient manufacturing**	• Improved industrial processes to reduce virgin inputs for key manufacturing industries • Reduce yield losses • Divert scraps	Circularity rises from 7.9% to **8.2%.** Reduction of material footprint by **3.8%**, decrease to **30 million tonnes.** Co-benefits: Reduced energy consumption and GHG emissions, value and employment creation, strengthened competitiveness.
	3.2 Employ R strategies for machinery, equipment and vehicles	• Increase the lifetime of machinery, equipment, and vehicles • Increase in remanufacturing, refurbishment, repair and maintenance, upgrade, and reuse services	
4. POWER CLEAN MOBILITY	**4.1 Embrace a car free lifestyle, improved modal shift and flex work**	• Car-sharing • Increase public transport occupancy • Flexible, hybrid mix homeworking	Circularity rises from 7.9% to **8.4%.** Reduction of material footprint by **5.9%**, decrease to **29 million tonnes.** Co-benefits: Reduced GHG emissions, improved air quality, greater access to mobility through improved sharing and public transport systems.
	4.2 Create efficient vehicles and electrify fleet	• Prioritising lightweight vehicles • Electrification of buses and private cars	
5. LEVERAGE PUBLIC PROCUREMENT	**5.1 Cap public stock expansion & procure food sustainably**	• Cap public stock expansion • Use secondary materials for new construction • Increase retrofitting • Dietary shift towards a plant-based diet in public food purchases • Cut waste generation and maximise food recycling to produce less food	Circularity rises from 7.9% to **11%.** Reduction of material footprint by **2.9%**, decrease to **30 million tonnes.** Co-benefits: A range of environmental benefits, opportunities for new business models, and awareness raising.

SCENARIOS, INTERVENTIONS & STRATEGIES

SCENARIOS	INTERVENTIONS	STRATEGIES	IMPACT AND MATERIAL FOOTPRINT
6. JOURNEY TOWARDS SUSTAINABLE TOURISM	**6.1 Prioritise local tourism**	• Prioritising local tourism over tourism abroad	Circularity stays at **7.9%.** Increase of material footprint by **0.3%**, maintained at **31 million tonnes.** Co-benefits: Reduced GHG emissions, improved air quality, greater access to mobility through improved sharing and public transport systems.
7. WELCOME A CIRCULAR LIFESTYLE	**7.1 Embrace a 'material sufficiency' lifestyle**	• Circular textiles (reusing, repairing, DIY, donating, recycling) • Minimalist lifestyle of furniture and home appliances, increased reparation • Non-market and community-based services • Local travelling and leisure • Reduced consumption of plastic products • Preference of recycled and digital over physical paper products	Circularity rises from 7.9% to **9.1%.** Reduction of material footprint by **13.5%**, decrease to **27 million tonnes.** Co-benefits: Improved wellbeing, less waste, litter and pollution, more inclusive and resilient communities.
COMBINED	**The power of combined interventions**	**This row** presents the baseline result for enacting all scenarios in combination with each other. It does not make particularly bold or ambitious assumptions. In this case, the category 'other mineral waste' has not been considered as construction and demolition waste suitable for recycling.	Circularity rises from 7.9% to **16.1%.** Reduction of material footprint by **48%**, decrease from 31 to **16 million tonnes.**



5

JOBS AND SKILLS

TO ACCELERATE THE CIRCULAR ECONOMY

The enabling role of the workforce

The previous chapter outlined the impact a transition to a circular economy could have on Northern Ireland's Circularity Metric and material footprint—but what about the role of people and their skills? A labour market that anticipates and plans for the transition to circularity can help accelerate it, while also safeguarding jobs. But, the workforce will need the right competencies to put the circular economy strategies forward in this report into practice. Workers, employers, and education and training providers play a central role in the circular economy, which is often overlooked. After all: the transition to circularity cannot be realised without a strong workforce to drive it. But what kinds of jobs and skills will the shift require? A baseline assessment of employment in Northern Ireland generated by current circular economy activities was conducted. This found that almost one-tenth of jobs in Northern Ireland (8.9% or just under 70,000) are contributing to the circular economy, either directly or indirectly. Our analysis found that beyond jobs that directly relate to the management of materials and waste, the understanding of circular jobs is limited. Based on qualitative data from a review of existing research and policy strategies, and 12 expert interviews with stakeholders in Northern Ireland, this chapter explores the jobs and skills necessary to realise the scenarios put forward in the previous chapter to close the country's Circularity Gap in an equitable way: one that future proofs Northern Ireland's labour market and benefits work and workers.

JOBS AND SKILLS IN THE CIRCULAR ECONOMY

Businesses, government and the people that work within them and across sectors in Northern Ireland all have a vital role to play in seizing the opportunities the circular economy presents. They also have a role to play in ensuring a just transition to the circular economy that is positive for people and the planet in the long-term. Collaboration and investment in careers development and skills pathways will help ensure that decent and inclusive job opportunities are available to workers across sectors and with varying skills levels; it will also spur the adoption of circular business models, which may require new and different job roles and ways of working.

This chapter outlines how attention for the labour market is vital for achieving a circular economy and doing so in an equitable way. We dive into the current labour and skills landscape in Northern Ireland, and examine the job roles and skills that will need to be developed across four key sectors: Bioeconomy and agriculture, Construction, Advanced manufacturing and Tourism. Jobs and skills in the Bioeconomy and agriculture, Construction and Advanced manufacturing sectors are key to bridging the Circularity Gap, while the Tourism industry—and other service industries—can play a crucial supporting role.

In our analysis, we translate how circularity can impact Northern Ireland's labour market and what kinds of job opportunities it will present through three descriptive lenses: transformation (+/-), increase (+/++) or decrease (-/--). We do not provide an exhaustive list of roles: the examples given in this chapter instead serve to paint a picture of the range of job opportunities that can emerge from implementing circular business models.

CIRCULAR ECONOMY AND THE LABOUR MARKET

The opportunities a circular economy presents for the environment and economy have been made clear throughout this report—but society stands to benefit, too, if given the proper attention. The need to consider employment in the circular economy has been emphasised by the UK Green Jobs taskforce[182] and in the draft *Green Growth Strategy* for Northern Ireland.[183] If not anticipated and overcome, skills shortages threaten to derail long-term environmental goals.[184] But if managed well, the transition can give way to decent work opportunities, opening up jobs in sectors directly involved in closing material cycles (remanufacturing and resource management, for example), and in areas that can enable or indirectly support the circular economy (such as education, design and procurement).[185] Promoting work for a circular economy, therefore, isn't only concerned with typically 'circular' sectors, like repair and recycling: it will have a transformative impact across sectors and will open up new roles in new markets while also redefining the tasks and skills needed to carry out existing roles.

Alongside these opportunities, the transition will likely see declining employment in extractive industries: mining, for example. Workers from sectors in decline can be redeployed in sectors where the circular economy will grow—but foresight and planning are required to maximise this potential.

Adopting narrow definitions of the circular economy focused on recycling and waste strategies, the net gains in employment that could result from the transition are thought to be positive but modest.[186,187] For Northern Ireland specifically, research estimates that while moving towards a circular economy could bring between 13,000 and 17,000 jobs, the predicted net effects are modest or neutral.[188,189] However, these approaches take a limited view of circularity and fail to consider its full potential to stimulate reuse, rental and leasing and repair activities that are significantly more labour intensive.[190,191] What's more, it is important to not just focus on the number of new jobs the circular economy can create, but to also consider the new ways of working and skills needed within existing jobs to enable the circular economy. Doing so can also ensure that the transition is inclusive, supports the development of the current workforce and provides opportunities for people in and out of work.[192]

NORTHERN IRELAND'S LABOUR MARKET

Northern Ireland's labour market is facing a period of particularly heightened uncertainty. The covid-19 pandemic has reduced economic output and corresponding increases in unemployment were prevented by furloughing thousands of jobs.[193] For many sectors, the focus has remained on short-term immediate needs for recovery. This is also compounded by continued uncertainty over the future of the UK's relationship with the EU and how businesses, investors and workers will respond to Northern Ireland's unique role in supplying and servicing both the UK and EU markets.

Beyond these ongoing critical challenges, Northern Ireland's labour market also faces a series of structural challenges. A lack of higher-paying jobs and low productivity levels have been recognised across the UK—and particularly in Northern Ireland, where productivity levels sit 17% below the UK average. An OECD review attributes this to persistently low levels of adult skills—as well as employees not using the skills that they have to their full potential.[194] While the levels and rates of unemployment are low, there are also high rates of economic inactivity, representing a larger potential supply of labour that is currently untapped.[195]

The need to balance the skills acquired through formal qualifications with the labour market's needs poses a further challenge. Analysis from the Northern Ireland Skills Barometer's 2021 edition highlights an undersupply in engineering, technology, and physical and environmental sciences in particular—skill sets particularly demanded to help narrow and slow material flows.[196] And in addition to filling the new circular jobs to be created, there will also be a need to replace jobs as older workers enter retirement.[197] For this, vocational, practical and work-based learning throughout all stages of working life is also likely to be critical.

There are a number of ongoing skills and education system reforms in place to address these longstanding challenges, and make the most of the opportunities. Policy and reform efforts are increasingly focusing on work-based learning, and apprenticeships in particular. Sectoral partnerships between local employers and qualification experts have already been developed across 15 areas, to review trainings and curriculums with the aim of ensuring trainees are industry-ready. Each of the six further education colleges has a dedicated lead coordinator on developments for a particular industry, and is responsible for engaging local businesses and employers on behalf of the further education sector.

A number of post-covid recovery and active labour market policy packages have also been made available: while they don't directly target a green recovery or the circular economy, these provide support for those seeking work or upskilling opportunities. The *Kickstart* scheme[198] provides six-month funded work placements for young workers aged 16 to 24, while the *Restart Programme* provides up to 12 months of tailored support for those out of work. The *Skills for Life and Work* programme[199] provides low-qualified young people with the support and foundational skills needed to progress to further education, apprenticeships or sustained employment. Those in receipt of welfare benefits can also avail of the voluntary *Work-Ready Employability Services* programme[200] to develop key skills to improve their job opportunities. Meanwhile, the *SKILL UP* programme[201] offers any adult the opportunity to pursue free, accredited, short training courses in economically relevant subjects including digital skills, green technologies, leadership and management.

Despite its structural labour market challenges, Northern Ireland has particular areas of strength—identified in its *10x Economy strategy*[202]—such as advanced manufacturing. The circular economy strategies identified in this report can build on these areas of strength, while also directly ensuring that supply chains and traditional parts of the country's economy such as agri-food, tourism and hospitality and construction are part of this transformation. Before investigating the enabling role of jobs and skills in transforming our four priority sectors, we first present a baseline for employment that contributes to the circular economy in Northern Ireland across sectors.

CIRCULAR JOBS IN NORTHERN IRELAND

Measuring employment that contributes to circularity

In offering an alternative to the dominant 'take-make-waste' model that Northern Ireland—and much of the world—lives within, the circular economy is invoking a systems overhaul. This presents labour markets with varied opportunities: from generating jobs in service and labour-intensive industries to redistributing jobs across communities. The core pillars behind preserving a material's maximum value, for as long as possible, hinge on processes that demand labour: reuse, repair, remanufacture and recycling, for example. In the introduction of new design strategies, production processes and business models, the type of work that will be undertaken will be reshaped, in essence, creating new jobs or transforming existing ones. This change will require skills from across the spectrum, with implications for workers from both theoretical and vocational educational pathways.

Our analysis follows an international standard developed in collaboration with the UN Environment Programme,[203] and defines circular jobs that—both directly and indirectly— contribute to one of the strategies laid out by Circle Economy's Key Elements framework (see page 66). It accounts for the interactions between sectors and trade in materials, and demonstrates the width and breadth of the circular labour market, encompassing sectors ranging from waste management to the creative industries. Jobs in sectors that are a core part of the circular economy—based on sector classifications—provide an input to this calculation.

- **Core circular jobs** are all jobs that ensure the closure of raw material cycles, including jobs in repair, renewable energy, and waste and resource management. They form the 'core' of the circular economy—and are often what people would think of when they hear 'circular jobs'.
- **Enabling circular jobs** are jobs that remove barriers to and enable the acceleration and upscaling of core circular activities. These may arise in leasing, education, design and digital technology. They form the supporting shell of the circular economy: without these, core circular jobs will be less likely to flourish.
- **Indirectly circular jobs** are jobs that indirectly uphold the circular economy by using core circular products and services.

RESULTS OF THE CIRCULAR JOBS CALCULATION

Almost one-tenth of jobs in Northern Ireland (8.9% or 69,600) are contributing to the circular economy, either directly or indirectly. The other 91% of the workforce is still operating in a linear economy, in alignment with the present take-make-waste paradigm. The number of jobs in sectors, local authority areas and regions of Northern Ireland can also be explored on the Circular Jobs Monitor.[204]

Core circular jobs (5,900 workers, or 8.5% of total circular jobs)

- Accounting for the interactions between sectors, and where the input materials are sourced from, we estimate that **5,900 jobs** are core circular jobs that directly contribute to the circular economy in Northern Ireland.
- **3,300 jobs** fall under recycling, materials and waste recovery. This amounts to under half of jobs (46%) in the waste sector: this is because only a limited share of high-volume waste materials are cycled back into use.
- An additional **2,300 jobs** (3.3% of circular jobs) stretch the lifetime of products and equipment through repair and maintenance.
- The renewable energy sector boasts only 300 circular jobs, showing that the potential for renewable energy production is largely unexploited.

Enabling circular jobs (9,300 workers, or 13.3% of total circular jobs)

- Due to its role in servicing other sectors, the digital technology sector generates **1,800 circular jobs** in Northern Ireland.
- A further **3,000 jobs** are related to circular business models (4.3% of circular jobs) such as leasing, rental and sharing products as services (Product-as-a-Service) to use instead of goods to own.
- **2,500 circular jobs** (3.5% of circular jobs) serve to strengthen and advance knowledge by providing training and know-how to businesses within the core circular sectors.
- Only **900 jobs** service core circular sectors through design, revealing untapped potential for circular design activities.
- Another **1,100 jobs** aid core circular sectors in collaborating with other organisations, in order to improve their processes and employee administration.

Indirectly circular jobs (54,400 workers, or 78.2% of total circular jobs)

- The vast majority of circular jobs are generated by sectors indirectly supporting the circular economy, accounting for more than three-quarters of all circular jobs. This shows the important role that jobs across all sectors in Northern Ireland can play in supporting the circular economy.
- These jobs are mainly generated through demand for core circular products or services by the manufacturing (**9,500 circular jobs**), health and social work (**6,000 circular jobs**), administrative services (**5,900 circular jobs**) and construction sectors (**4,300 circular jobs**). In the case of administrative services this includes, for example, purchasing officers for a call centre that buy second-hand or refurbished equipment, therefore indirectly contributing to the circular economy.

Jobs in core circular sectors

Other sector-based approaches to measuring circularity in the labour market largely only consider jobs in core circular sectors, typically limited to repair, second-hand shops, renewable energy and recycling. In total, more than 14,100 jobs are in core sectors of the circular economy when considering this method. This is in line with previous estimates for Northern Ireland calculated by WRAP for 2013,[205] but does not take the interactions between sectors into account.

Total circular jobs	Total circular jobs as a % of total
69,600	8.9%

Circular jobs breakdown:

CORE

- **Prioritise** regenerative resources
- **Stretch** the lifetime
- **Use** waste as a resource

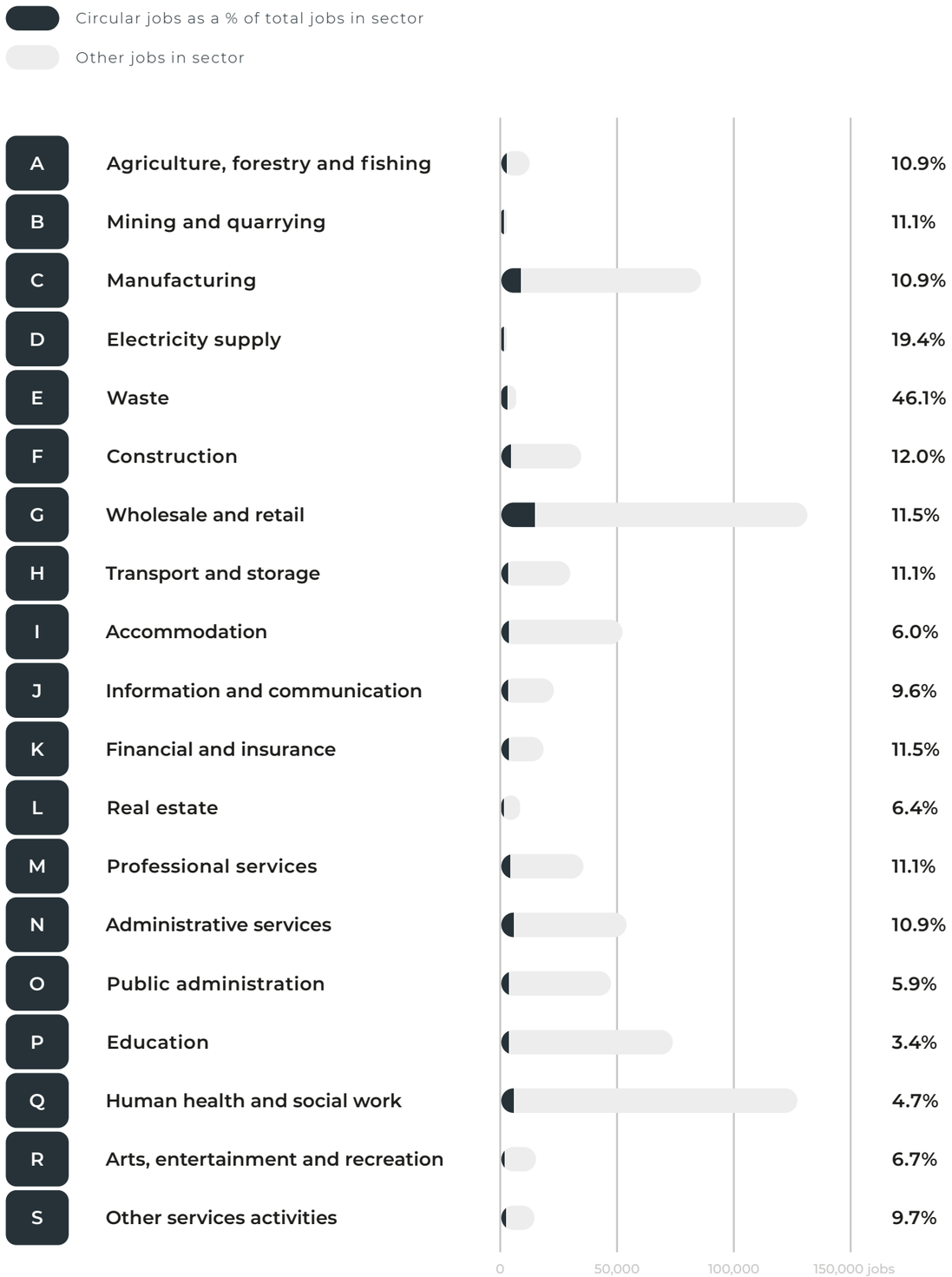
ENABLING

- **Design** for the future
- **Rethink** the business model
- **Incorporate** digital technology
- **Team up** to create joint value
- **Strengthen and advance** knowledge

INDIRECTLY

Jobs that indirectly uphold the circular economy. These jobs occur in sectors that do not play a direct role in furthering the transition to the circular economy but can still adopt circular strategies.

Figure six shows the baseline assessment of the number of jobs generated by circular economy activities across sectors.



SKILLS TO POWER THE CIRCULAR ECONOMY IN PRIORITY VALUE CHAINS

The employment analysis laid out in the previous section paints a picture of the number and range of jobs that already contribute to the circular economy in Northern Ireland. This section dives deep into three sectors that will be key to Northern Ireland's circular economy: bioeconomy and agriculture, construction and advanced manufacturing. It also looks at the role that jobs and skills in the tourism industry can play in enabling the circular economy.

1. BIOECONOMY AND AGRICULTURE

Sector trends and employment

Agriculture is 'the iron of Northern Ireland': a critical industry boasting natural factors that support a vibrant bioeconomy including high-quality grasses and healthy and productive soils. As noted previously in this report, the vast majority—over 70%—of land in Northern Ireland is used for agriculture, including areas best suited to community grazing on hillsides and peatland. The concentration of agricultural activity, manure from grazing livestock and use of synthetic fertilisers has contributed to excess of phosphates, ammonia in soils and emissions of nitrous oxide and methane—greenhouse gases more potent than carbon dioxide.[206]

Traditional and innovative methods to return manure and sewage nutrients to pasture through organic fertilisers, or otherwise use biowaste as an energy source, are developing to support a more circular agriculture sector. The adoption of digital technologies such as the use of drones, monitoring software, geographic information system (GIS) mapping, as well as hydroponics, can also enhance organic crop production and facilitate better soil management within Northern Ireland, that can also reduce the dependency on imports for foods such as garlic from China.

Across the island of Ireland, the adoption, scaling up and commercialisation of biorefineries and biogas plants to replace reliance on fossil resources are well underway.[207,208] Multiple opportunities are created through anaerobic digestion to turn this waste—and food waste from the tourism and hospitality sectors—into biogas and digestate. The stakeholders interviewed, however, emphasise that caution is needed in using grass as an energy source for such plants, instead of as a source of high-quality, local feed for livestock. However, sufficient incentives to substitute chemical fertilisers with organic alternatives are not yet in place.[209]

The viability of farming in Northern Ireland, without sufficient government support, is considered low. The sector is characterised by many part-time, small-hold farmers,[210] responsible for around half of all farms, with insufficient interest from young individuals to take over for older farmers leaving the industry. There is also a degree of scepticism towards external parties and scientists, and reluctance for training, reskilling or keeping up to date with latest schemes, trends and technologies. Farmers that do not adhere to environmental principles are seen as having a competitive advantage with lacking incentives to support sustainable and circular strategies.

Job impacts of circular strategies

Shifting to strategies that cut output from livestock farming and radically reduce herd numbers raises some valid concerns for food processors and farm workers. A KPMG analysis of policy to reduce the sector's footprint to meet the net-zero carbon target by 2045 illustrates that major herd reductions are necessary, particularly for beef, dairy and sheep.[211] The findings suggest, however, that by limiting the reduction in herd numbers to 30% or less, the impact on jobs could be minimal.[212] By embracing the strategies for a circular food system outlined in this report, not only can these downsides be mitigated, further job opportunities can be created through the bioeconomy and adoption of environmental farming practices, provided support is in place to support farms in their transitions.

The ascent of environmental farming and circular agriculture practices will lead to an increased demand for specialist advisors including **agronomists and animal nutritionists**: independent advisors on soil health and animal feed quality, respectively, and ways to monitor, manage and maintain it. Technical ecological knowledge of soils, nutrients and proteins is necessary, combined with interpersonal skills and empathy for different farms and farmers' situations and needs. Initiatives to restore and improve woodland, rewet bog and peatlands and cultivate biodiversity through hedgerow management can also generate job opportunities for those in rural communities.[213,214]

If the bioeconomy sector adopts circular strategies, employment can be fostered in agri-food and industrial biotechnology sectors, alongside many of the materials being able to be sourced locally from rural and coastal areas and businesses.[215] Jobs in biorefinery and anaerobic digestion offer a mix of occupations, ranging from **process operators and bio-technicians to researchers and chemical engineers.**

Skills pathways for circular agriculture and bioeconomy

To realise these job opportunities, it is important to develop the right skill sets and education infrastructure. To counter a lack of awareness of sustainable farming techniques,[216] greater efforts may be needed at all levels of education to teach the value of sustainability within agrifood chains—thus preparing prospective farmers and farm workers for the future. For more immediate impact, environmental farming business development groups can be implemented to develop the knowledge and skills needed to support the adoption of circular strategies among farmers and specialist advisors.[217]

Stakeholders also report an increasing need to combine traditional pathways within the agri-food sector with business and management, as well as emerging areas such as data analytics. One approach could be to combine learning pathways at agricultural colleges, such as CAFRE, with business schools, like the Ulster University campus in Jordanstown. Facilitating meetups and platforms to share understanding, data and expertise across the digital-farming divide may help develop digital skills among farmers and specialist advisors, and can support decision making and the adoption of new approaches.

Within the bioeconomy, a common issue is the need to develop sufficient work-based and vocational pathways for technicians and technical operators. At higher education levels there is also a need to facilitate work across biology, chemistry, engineering and other disciplines to effectively develop, scale and commercialise novel products and processes.[218] Collaboration between the bioeconomy and the agri-food value chain can also provide a steady source of food waste as inputs to bio-industrial processes.

2. CONSTRUCTION AND THE BUILT ENVIRONMENT

Sector trends and employment

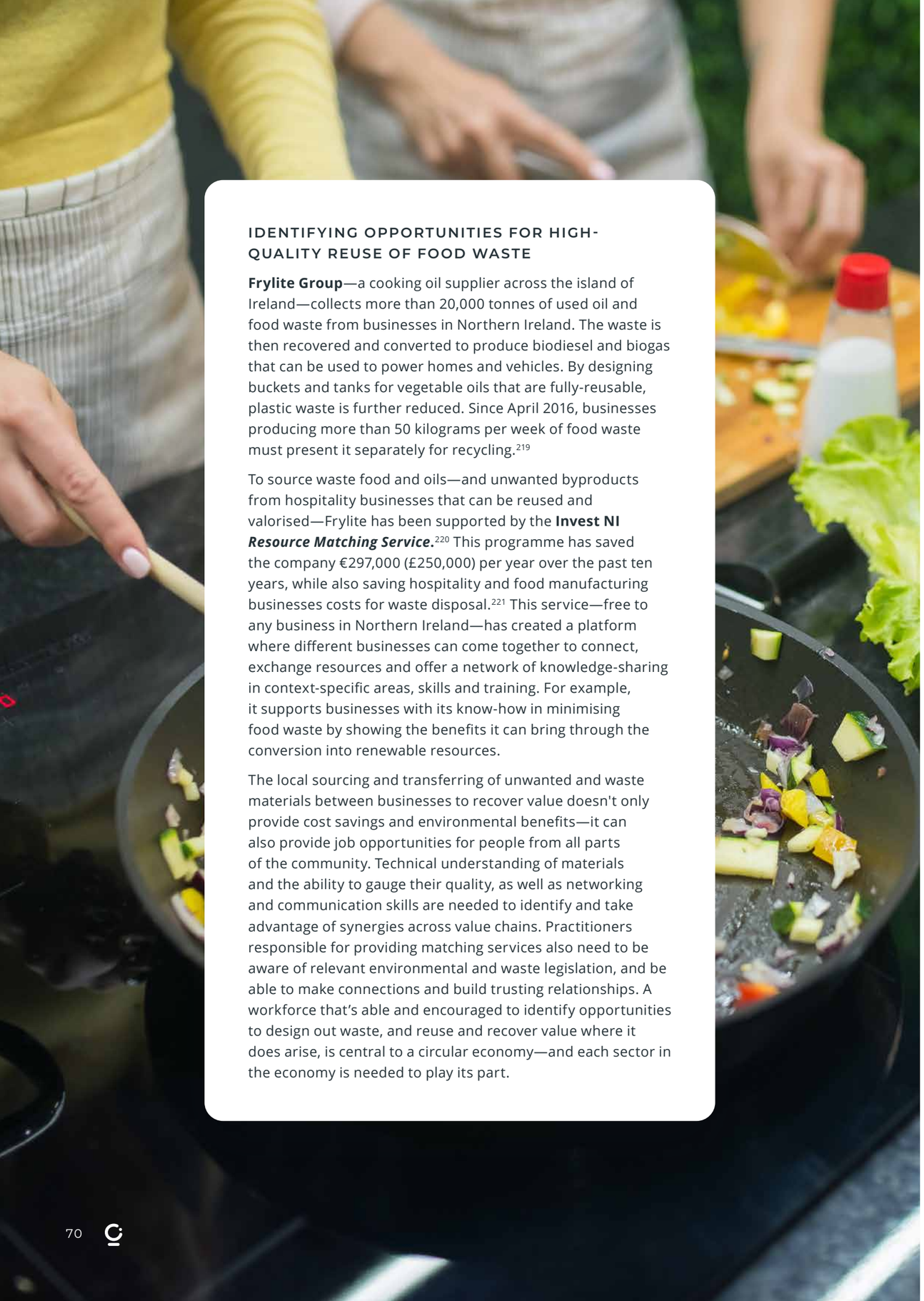
Developing a circular built environment that prevents the depletion of materials and energy will likely require a radical attitude shift, rather than simply bridging a knowledge gap. The sector is typically—and understandably—driven by a risk-averse mindset that seeks to limit costs in line with clients' requirements, is bound to tight regulations (such as those for safety), and is not traditionally required to hold responsibility for projects past the point of delivery. However, these conventions are misaligned with the extended responsibility needed to support the circular economy.

The construction sector in Northern Ireland is male-dominated[222] and traditionally provides opportunities for school leavers lacking qualifications or with on-the-job training acting as a potential means to escalate to higher-level, higher-paid work: for example from labourer to supervisory and management roles). 4,300 jobs in the construction industry—12% of total employee jobs in the sector—contribute to the circular economy in Northern Ireland. Shortages in skilled tradespeople and an ageing workforce,[223] however, may make it more challenging to adopt labour-intensive, circular strategies—so constructing a circular built environment will require efforts to develop and attract the 'right' talent.

More than 90% of the building stock that we will need in 20 to 30 years has already been built—so the greatest impact can be made by slowing energy and material flows in existing stock. This can be done through strategies such as renovation and refurbishment, which can be carried out to integrate energy- and resource-efficiency practices: many job opportunities lie in this arena.

Job opportunities in circular construction

Shifting from oil- and gas-based home heating to heat pumps or alternative energy sources—such as green hydrogen, hydrogenated vegetable oil (HVO) or biogas from anaerobic digestion plants—provides one such set of job opportunities. However, some uncertainty remains over the energy security and life-cycle carbon impacts of these alternative fuels. It must also be noted that other issues first need to be addressed before integrating innovative ideas into building stock: repairing leaks in domestic water systems, for example, and installing insulation and draught-proofing to ensure buildings are sufficiently air-tight. These renovation works are expected to



IDENTIFYING OPPORTUNITIES FOR HIGH-QUALITY REUSE OF FOOD WASTE

Frylite Group—a cooking oil supplier across the island of Ireland—collects more than 20,000 tonnes of used oil and food waste from businesses in Northern Ireland. The waste is then recovered and converted to produce biodiesel and biogas that can be used to power homes and vehicles. By designing buckets and tanks for vegetable oils that are fully-reusable, plastic waste is further reduced. Since April 2016, businesses producing more than 50 kilograms per week of food waste must present it separately for recycling.[219]

To source waste food and oils—and unwanted byproducts from hospitality businesses that can be reused and valorised—Frylite has been supported by the **Invest NI *Resource Matching Service*.**[220] This programme has saved the company €297,000 (£250,000) per year over the past ten years, while also saving hospitality and food manufacturing businesses costs for waste disposal.[221] This service—free to any business in Northern Ireland—has created a platform where different businesses can come together to connect, exchange resources and offer a network of knowledge-sharing in context-specific areas, skills and training. For example, it supports businesses with its know-how in minimising food waste by showing the benefits it can bring through the conversion into renewable resources.

The local sourcing and transferring of unwanted and waste materials between businesses to recover value doesn't only provide cost savings and environmental benefits—it can also provide job opportunities for people from all parts of the community. Technical understanding of materials and the ability to gauge their quality, as well as networking and communication skills are needed to identify and take advantage of synergies across value chains. Practitioners responsible for providing matching services also need to be aware of relevant environmental and waste legislation, and be able to make connections and build trusting relationships. A workforce that's able and encouraged to identify opportunities to design out waste, and reuse and recover value where it does arise, is central to a circular economy—and each sector in the economy is needed to play its part.

increase the demand for roles such as **installers and maintenance technicians**, as well as **construction managers** and those adopting **quality control**, as well as **coordinating roles** to support (deep) renovation of older buildings. By prioritising measures to firstly fix leaks and draughts, issues such as energy-saving equipment performing poorly due to lacking competence for correct installation and usage advice can be avoided.[224,225]

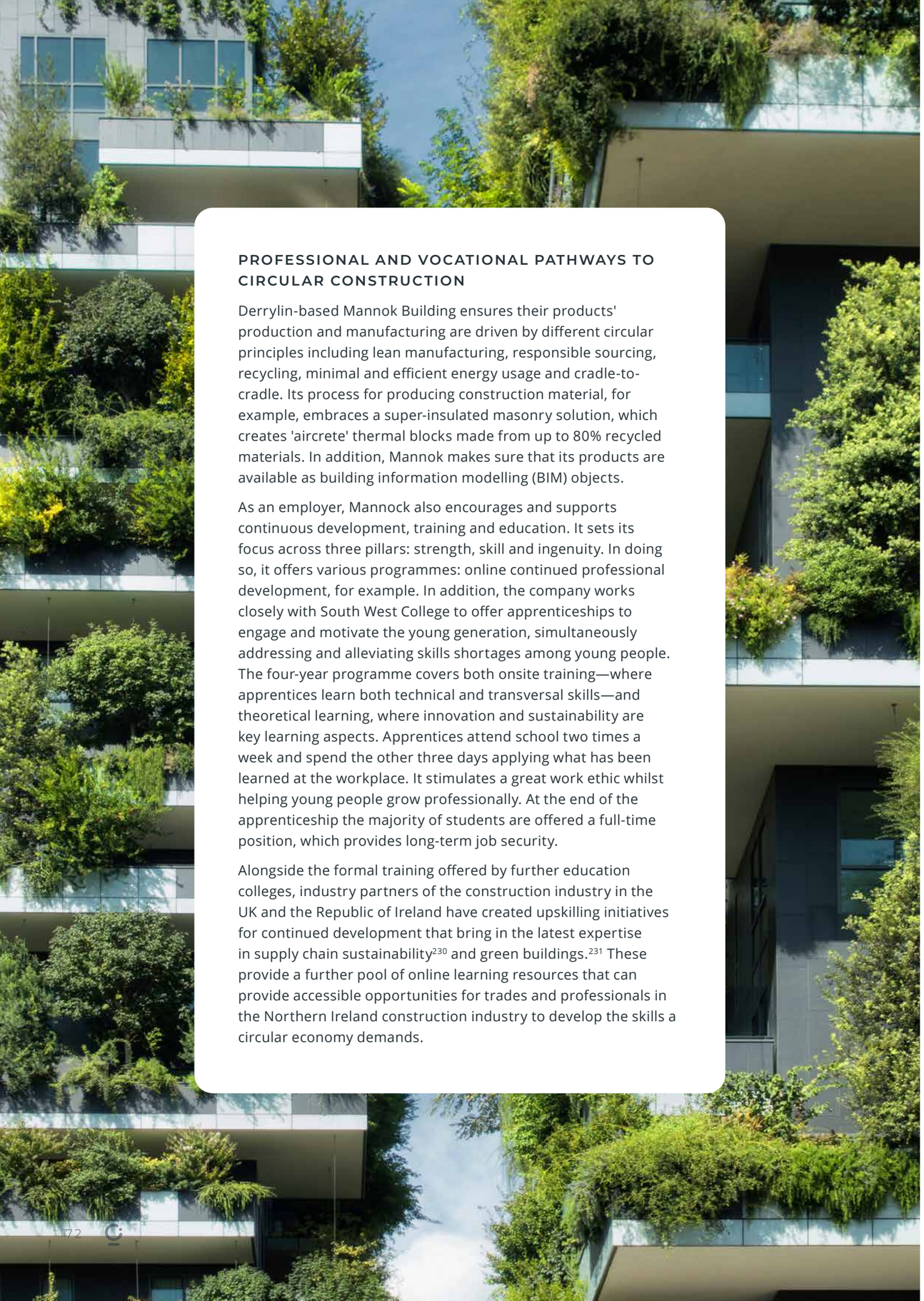
The Energy Strategy for Northern Ireland consultation paper[226] expects that 13,700 job opportunities could be created in the coming three decades, in addition to the need to re-skill and retrain existing workers. Over the next five years, CITB-NI estimates that the industry will need to recruit an average of 1,000 employees each year based on forecasts for construction output.[227] By adopting strategies that decrease the need for new buildings, efforts can be focused on securing the skills needed to future-proof the stock of existing buildings.

A further opportunity lies in the closed-loop cycling of building materials that diverts construction materials and components away from landfill and to be used in renovations and the construction of new buildings. This can create jobs in the **sourcing, sorting, testing and supply of high-quality secondary materials** while also reducing the waste produced by the sector. Methods like digital tracking and imaging for materials, and the adoption of material passports, are gaining traction to enable sustainable design, disassembly and reuse. Digital skills in data analysis, project management, building information modelling (BIM) and computer-aided design (CAD) will increasingly be needed to enable higher value reuse of materials at end-of-life.[228]

Skills pathways for circular construction

Trade- and profession-specific skills and increasingly digital skills are well provided for by existing higher education and further education offers in Northern Ireland. Employers and providers of specific energy-saving and circular technologies are also increasingly engaged with education providers, to ensure the latest practices and techniques are taught. The construction hub at South EastERN Regional College, for example, has partnered with the manufacturers EOGB and Baxi Thermea to provide training on alternative fuelled boilers.[229]

Further capacity building to embed fundamental circular principles—such as those centring on material reuse and refurbishment practices—is currently lacking. Stakeholders have also reported a lack of knowledge across various trades and professions that's needed for cooperation in renovation projects as well as for circular building practices. Higher education and further education colleges could explore ways to build a shared understanding between design and practice for construction. Beyond education, employers also have a responsibility to upskill their workforce, and promote pathways that can help overcome shortages of skilled labour (see case study on the next page).



PROFESSIONAL AND VOCATIONAL PATHWAYS TO CIRCULAR CONSTRUCTION

Derrylin-based Mannok Building ensures their products' production and manufacturing are driven by different circular principles including lean manufacturing, responsible sourcing, recycling, minimal and efficient energy usage and cradle-to-cradle. Its process for producing construction material, for example, embraces a super-insulated masonry solution, which creates 'aircrete' thermal blocks made from up to 80% recycled materials. In addition, Mannok makes sure that its products are available as building information modelling (BIM) objects.

As an employer, Mannock also encourages and supports continuous development, training and education. It sets its focus across three pillars: strength, skill and ingenuity. In doing so, it offers various programmes: online continued professional development, for example. In addition, the company works closely with South West College to offer apprenticeships to engage and motivate the young generation, simultaneously addressing and alleviating skills shortages among young people. The four-year programme covers both onsite training—where apprentices learn both technical and transversal skills—and theoretical learning, where innovation and sustainability are key learning aspects. Apprentices attend school two times a week and spend the other three days applying what has been learned at the workplace. It stimulates a great work ethic whilst helping young people grow professionally. At the end of the apprenticeship the majority of students are offered a full-time position, which provides long-term job security.

Alongside the formal training offered by further education colleges, industry partners of the construction industry in the UK and the Republic of Ireland have created upskilling initiatives for continued development that bring in the latest expertise in supply chain sustainability[230] and green buildings.[231] These provide a further pool of online learning resources that can provide accessible opportunities for trades and professionals in the Northern Ireland construction industry to develop the skills a circular economy demands.

3. ADVANCED MANUFACTURING

Sector trends and employment

As global consumption continues to rise, it will be of utmost importance to reduce and reuse what we already have and expand the lifetime of products and equipment. Advanced manufacturing and engineering is a key strength of Northern Ireland's economy, with potential for growth and the creation of highly productive, well-paid jobs.[232] Whether it is producing precision parts for aerospace equipment or industrial shredders for confidential waste, such equipment sits at the centre of innovation in today's economy. In catering for an array of societal needs, it also consumes considerable resources and metal ores, in particular.

9,500 jobs in the manufacturing industry—11% of total employee jobs in the sector—contribute to the circular economy in Northern Ireland. The country's strengths and expertise regarding innovative materials will be particularly relevant for the transition, and presents opportunities for export to international markets where demand for recycling equipment, materials removal and waste collectors are expected to grow as other countries take up strategies to cycle materials and valorise waste. While indirectly supporting circular strategies, there is also a need to embed circular principles in their design and use to extend their service life, through predictive maintenance, and the reuse of parts and materials at end-of-life in the production of new equipment.

Lightweighting, lean manufacturing and other approaches to resource efficiency are already embedded within Northern Ireland's manufacturing sector. By better integrating circular business models, the country can support the creation of high-quality job opportunities in after-sales financing, monitoring and repair services. Product-as-a-Service and after-sales service models can typically be developed to meet client needs for new machinery and capital equipment that can incentivise the design and manufacture of longer-lasting products that are easier to repair and disassemble. In these business models, the consumer does not buy a product to own it, but rather uses and pays for the product via a lease or pay-per-use basis. This places the onus on producers to keep the products running (often helped along by digital monitoring tools such as predictive maintenance) and by providing repair services as part of an integrated product offer to extend machinery's lifetime.

Using waste as a resource presents a further opportunity for the advanced manufacturing sector. A number of reprocessors in Northern Ireland have indicated that they would benefit from increased and higher-quality local recyclate—but unfortunately, due to collection methods, the recyclate is often unusable and exported.[233] By reshoring this material for reprocessing into new products, value can be retained and the reliance on commodity markets reduced—and in so doing, create jobs and support the local economy.[234]

Job impacts and skills pathways for circular manufacturing

Boosting the rate at which capital equipment is refurbished, maintained and repaired leads to increased job opportunities for **test engineers and repair technicians. Demand planners**, who oversee the supply and demand requirements of products, their supply chains and operations, are also central to making repair and refurbishment a core and profitable business stream. The emerging use of bio-based materials in designing manufactured products, and the incorporation of secondary materials from one industrial process as inputs into another, known as industrial symbiosis, will also create demand for industrial symbiosis facilitators, materials and research analysts, and transform the work of product design and development engineers. Product designers will also need to embrace designing for disassembly to ensure that new products can be taken apart at end-of-use to facilitate their reuse or repair, or the refurbishment of components. This will require a stronger understanding of manufacturing processes and material properties among workers.

As in the construction sector, the manufacturing workforce in Northern Ireland is ageing and male-dominated.[235] Widening the pool of labour that the sector can draw on will be crucial for realising opportunities for job creation—and accelerating the circular transition. Aside from efforts to retain ageing workers and, for example, developing mentor programmes to engage them in the skills development of youth, few short-term fixes are available. There is a recognised need for role-modelling and measures for greater inclusion of women in particular.[236] Here, employers may follow the example of voluntary charters to take practical measures to support women in the sector and secure inclusive pathways for future recruits (see case study on the next page).

ENSURING HIGH QUALITY, CIRCULAR JOBS IN ADVANCED MANUFACTURING ARE OPEN TO ALL

Encirc, with its plant in Enniskillen, provides a circular supply chain for glass production, by integrating elements into its processes that minimise social and environmental impact. It doesn't just produce 100% recycled glass—it is also committed to reducing carbon footprints throughout its products' life cycle. Alongside industry body Glass Futures, Encirc has followed fuel-switch initiatives by using biofuel in its furnaces. This has given it the opportunity to create over 200 jobs, while securing current positions.[237] Alongside its circular production methods' environmental credentials, emphasis is placed on cultivating an inclusive culture, promoting equal opportunities and fostering transparency around its employees and recruitment processes.[238]

To address the low number of women working in advanced manufacturing—and increase the pool of talent from which they can draw—Encirc has implemented a 'women in manufacturing charter' to raise awareness around gender diversity and put it into practice.[239] This entails inclusive measures that can set an example for the rest of the manufacturing industry. For example, it has taken practical steps to remove names from applicants' CVs, committed to the use of gender-neutral language and integrated support policies that require at least three women on any shift. If replicated at industry level, such approaches can both improve outcomes for women in manufacturing and help to alleviate the skills shortages that the sector faces.

4. TOURISM

Sector trends and employment

The tourism industry is an important employer—and a heavy consumer of materials, food and energy resources in Northern Ireland. By reducing its environmental impact through activities related to hospitality, travel, food and consumer goods, the sector can act as an enabler for the circular economy. 3,150 jobs in the accommodation industry—or 6% of total employee jobs in the sector—contribute to the circular economy.

As one of the sectors hardest hit by the covid-19 pandemic, with over 14,000 jobs furloughed at its peak in mid-2021 through the Coronavirus Job Retention Scheme,[240] the sector has been in survival mode and continues to face staff shortages.[241] Strategic investments and decisions to reduce environmental impacts, and adopt sustainable consumption practices may have been sidelined by the immediate pressures to keep businesses operational. The general public and tourists are, however, increasingly aware of—and demanding more from—their holidays in terms of sustainability. Efforts among hotels and restaurants, that tend to be small and micro-businesses, tend to be focused on cost-cutting measures to recycle, and reduce energy and water use as well as food and packaging waste. Basic technologies to monitor usage and weigh waste are increasingly being adopted.

A further opportunity exists to draw more deeply on the provenance of local produce in the tourism 'offer'. Imported products that carry higher 'food miles' can tend to have both a higher environmental impact, and shorter lifespans with an increased risk of wastage. Local tourism and the promotion of local produce and visitor experiences can both cut environmental impact, and also support jobs in local agriculture and industry. Environmental improvement schemes and investment in rural areas that promote a circular agri-food sector, can also bring benefits to the tourism industry.[242]

Within the tourism sector, the general perception of circular economy and sustainability is centred on waste and packaging—as opposed to more structural systems-level solutions. Few establishments fully embrace sustainable tourism offerings, though there are with some exceptions, such as Salthouse. The concept of 'scatter hotels'—which repurpose vacant spaces above local shops and restaurants, allowing these spaces to act as the reception—provides an opportunity that can contribute to making the most of the existing stock of buildings. Optimising the use of buildings in this way can also contribute to a circular built environment.

Jobs and skills to enable sustainable tourism

The adoption of circular strategies to promote, adopt and boost sustainable tourism will likely shift the skills needed by employers and workers in the sector. The development of local tourism offers centred on rural and coastal community strengths in food and drink can also require different skill sets among **marketing executives**, while also indirectly supporting jobs among **artisanal food producers and farmers**.

Tourism and associated industry staff and management need to understand circular principles, increasingly collaborate across value chains and adopt new technologies to minimise waste. **Real estate and hospitality managers** embracing local tourism in networks of vacant spaces may also need to develop skills to effectively market and communicate their offer to clients, and collaborate together.

There is currently limited training dedicated to circular economy and sustainability topics provided by the industry, as well as among vocational education providers. As such, the development and uptake of dedicated training for teachers and trainers within the tourism and hospitality sector may be a practical starting point to build capacity and develop sustainability champions or advisors for the industry and within the education sector.

Masterclasses and workshops developed by Tourism Northern Ireland provide an exception that aims to raise awareness of sustainable strategies in tourism.[243,244] To overcome the inherent challenges in providing training to workers in sectors when time and budget for training is limited, such accessible, online offers can provide a meaningful springboard for the greater uptake of circular strategies. Experience gained from rapid development and roll-out on-demand, remote training in digital skills and resilience during the covid-19 pandemic could also serve as a model to offer introductory level courses on sustainability and circular strategies specific to service industries such as tourism. Sufficient incentives will likely be needed for this to be taken up widely, however.

High quality retrofit, renovation & refurbishment practices	Increase (++) in quality checks, inspectors, technical installers of resource saving technologies, construction trades, design engineers and repair operatives. Increase demand (+) in installers and maintenance technicians of heating systems fueled by alternatives to fossil-based oil and gas.	Construction Quality Control Construction Trades, Technical Installers and Repair Operatives Alternative Heating System Installers
Source secondary materials & optimise recovery through digital tools	Transformation (+/-) of procurement officers to source recycled or reusable materials. Increase (+) due to emerging companies specialising in urban mining. Transformation (+/-) of project coordinators and facility managers to integrate digital tools like BIM, CAD and GIS into existing roles.	Procurement Managers Project Coordinators, Facility managers Deconstruction auditors
Product design, repair, refurbishment and industrial symbiosis	Increased demand (+) for professionals involved in product and equipment design that incorporates bio-based and secondary materials.. Increased demand (+) for workers involved in predictive maintenance, on-the-spot repair, product refurbishment facilitated by digital devices to detect and report issues. Transformation (+/-) of business models to work collaboratively with partners across the value chain and in other industries to identify and implement circular strategies.	Design and Development Engineers Industrial symbiosis facilitators Material and Research Analysts Test Engineers Repair Technicians Demand Planners
Recover waste for organic fertilisers & biogas production		Bio Technicians, Process Operators Researchers
	Increase (+) in advisors on soil health, feed quality and related monitoring systems. Transformation (+/-) in agricultural work to adopt digital tools & new farming practices.	Agronomists & Animal Nutritionists Farmers & Farm Workers
	Transformation (+/-) towards local, sustainable tourism, which supports the adoption of circular strategies in supply sectors (food, accommodation, transport, consumer products). Transformation (+/-) in skills of tourism staff and management to understand circular principles, collaborate across value chains and adopt technologies to minimise waste. Indirect increase (+) in agri-food workers associated with rise in demand for local produce.	Tourism Managers Marketing Executives Real Estate and Hospitality Managers Artisanal Food Producers and Farmers

LEVERS TO INCREASE CIRCULAR JOBS

This report lays out a number of levers and scenarios that could be used to increase the number of jobs contributing to the circular economy. This can be achieved directly by stimulating core sectors—from renewable energy, repair and maintenance, to reuse and recycling—as well as by redirecting enabling sectors such as finance, research, design and digital services to serve regenerative inputs, extended product life-cycles, reuse and recycling. Jobs can also indirectly support the transition through the adoption of circular strategies across all sectors of the economy, for example, by using regenerative energy, water and materials, contracting maintenance and repair services to extend the life of buildings and products, and by using refurbished, secondary and local materials as inputs to production. For the circular strategies to be implemented and the economic opportunities they bring to be realised, it is first necessary to ensure the creation of pathways to develop skills in the workforce and those more distant from the labour market.

Education and training systems

Alongside higher education, vocational education and training (VET) offers enormous potential when it comes to fulfilling high-quality jobs key to the circular economy. However, different education pathways and current systems need to adapt to help accelerate the circular economy transition.

Within the education system itself, there is an increasing need to enhance collaboration between further education colleges, universities and employers, as well as private education providers of continued professional development. The latter tends to have greater flexibility to pilot new offerings and delivery models with employers and industry—which should be encouraged within colleges. This can be achieved by developing mechanisms and networks to share best practices, collectively tackle industry challenges and enable insights for feedback to ensure courses remain relevant. Further education colleges' dedicated enterprise-led model provides this connection to some extent, which could be bolstered by adopting a similar model of 'sustainability champions', or enterprise-led skill networks following the example of Skillnet Ireland.[245]

While work-based learning and apprenticeship pathways are growing and being supported, this is yet to become an integral part of higher education.[246] This will require greater collaboration and heightened shared responsibility between colleges, universities and employers, and will call for appropriate investment to ensure relevant study opportunities close to where circular jobs are based.[247]

Across each of the sectors and scenarios investigated, we have identified a need to attract workers and learners from different backgrounds and stages in life. Certain groups—like young people and women—face barriers to technical and digital trades and professions. For these groups, role models and mentoring programmes, and careers guidance, can be invested in that showcases what the future of work in under-represented sectors could look like in a circular economy, and the ways in which the emerging work differs from what's traditionally been done.

The skills system can also support the circular economy through the development of transversal, foundational skills—both among inactive adults and young people entering the labour market after education. The stakeholders interviewed report a sense that personal and communication skills are largely lacking and need to be developed before (re-)joining the workplace. Older workers and their employers also often lack incentives to undertake accredited learning to top-up their skills. In both respects, community-led, informal learning and coaching can be harnessed. Circular economy practices such as reuse, repair and refurbishment can resonate with both the young and old, and can be developed in a more practical, informal setting that may better suit those who lack the interest and motivation for formal learning offers (see case study on the next page).

CIRCULAR SKILLS IN THE COMMUNITY

Once we believe a phone, chair or other consumer good to be past its best days, throwing it away is the norm. A circular economy activates a mindset where these goods could receive a new life. Across Europe, different initiatives have been launched that pursue such a spirit and are active in implementing principles of reuse and repair of all sorts of things. The Northern Ireland Resource Network (NIRN)[248] is a project that invites members to promote less-waste living and rethink the life cycles of food, plastics, clothing, electronic devices and many other items.

At the same time, these initiatives bring people from the same community together to connect, network and share knowledge. This has the effect that people start talking across circles of friends and family about the benefits of applying circular principles to consume and preserve resources—and the likelihood that circularity becomes an integrated part of people's lifestyles grows. In the future, cross-border collaboration that stimulates engagement and exchange practises to repair, recycle and reuse items across organisations and borders will be crucial.[249] The term 'repair cafes' has gained increasing awareness across European countries, following a similar concept as the NIRN. The idea is to help one another using skills that have been around for many centuries—giving broken items a new life through the support of volunteers. The revival of this skill-set can help to meet demand for more repair workers and drives curiosity among communities in perseverance and resourcefulness.

Another similar example of a shared communal project is Men's Sheds. This provides a place to pursue practical interests at leisure, to practise skills and enjoy making and mending. While garden sheds and their activities are often solitary in nature, Men's Sheds instead seek to build social connections, and share knowledge and skills.[250]

POLICY LEVERS TO STIMULATE DEMAND FOR CIRCULAR SKILLS

Developing the skills needed can only be part of the solution. To accelerate the transition to a circular economy, a supporting policy environment is also needed that ensures that the skills developed for circular jobs are both demanded and used in the workplace. Procurement provides an example of a powerful tool to support demand for skills for the circular economy. By factoring social and environmental value into public procurement contracts that, for example, place additional value on the use of local, secondary materials or seek to repair existing equipment, it provides impetus for businesses to develop the knowledge and skills needed to deliver such contracts.

Stakeholders also highlighted the need to consider the role that land tenure and planning systems play in hindering circular strategies. Within the agriculture sector, an outdated conacre system of licences to use the crop typically means year-to-year tenure, with farmers often renting from multiple different owners. A resulting absence of long leases may increase the incentive to extract the maximum possible from the land, rather than manage it sustainably. The Republic of Ireland previously had a similar system and lessons may be drawn from the experience of how to remedy it through the introduction of tax relief incentives in 2014. The planning system can also hinder the repurposing of buildings for alternative uses, or the development of infrastructure needed to support the bioeconomy and industrial symbiosis. Identifying and, where appropriate, removing such impediments could help ensure that the economic opportunities of the circular economy—and its associated job creation potential—are realised.

6

FROM THEORY TO ACTION

Next steps

Already, Northern Ireland is pursuing a *Circular Economy Strategic Framework* to support and guide its transition to a more resource-efficient, environmentally friendly and socially just socioeconomic model. The strategic focus presented by the Department for the Economy has already prioritised eight focus areas, including four economic sectors (Bioeconomy and agriculture, Construction and built environment, Advanced manufacturing and Tourism) and four material streams (Food, Electronics, Packaging and Textiles). This report feeds into this strategic roadmap, with the aim of reflecting these focus areas. This chapter aims to deepen our analysis by providing specific commentary on the eight focus areas outlined above, and gives recommendations for their realisation, in line with the strategies given in Chapter four.

Strategies differ in their ability to steer and incentivise action—and the transition period for implementing them varies widely: while some may have short- or medium-term impact (think: encouraging a dietary shift among residents), others will come into play in the longer-term (think: designing buildings for disassembly at end-of-life). At the same time, some strategies can be put into action more quickly and easily—so-called 'low-hanging fruits'—while others will require a more systemic approach and will be more challenging to realise.

In bringing our strategies off the pages of this report and into Northern Ireland's reality, circular business models, greater investment in waste management infrastructure and supportive policy incentives will be key. Taxation will also have a critical role to play in providing actors with the right economic incentives to shift their behaviour, as well as steer consumer behaviour. And as of yet, circular business models are often unable to compete: regulatory and fiscal frameworks still largely disproportionately benefit deeply-ingrained linear thinking and approaches.

To devise clear next steps for the country, we have carried out desk research and analysed information from the Department for the Economy's Call for Evidence.[251] Next steps have been divided into short-term 'low-hanging fruits'—implementable within one to three years—and long-term, strategic shifts that could take five to ten years to realise.

ECONOMIC SECTORS

1. BIOECONOMY AND AGRICULTURE

Circular strategies and opportunities for this sector were first introduced in Chapter four: Scenario one explores the impact of a potential dietary shift toward plant-based, healthy foods, cutting food waste and ensuring food production is carried out more sustainably. However, other key levers to catalyse the circular transition remain: nutrient recovery and waste valorisation, crop diversification and taking a systems approach to support biodiversity.

Consider nutrient recovery through cascading, and the valorisation and utilisation of agriculture, food and forestry residues. In its recovery of valuable materials, Northern Ireland should aim to incentivise value hierarchies and cascading principles—ensuring that the value of 'waste' products is retained at the highest level possible.[252] The creation of high-value products—from pharmaceuticals to food and more sustainable packaging—should be prioritised well before fuel or energy generation, for example. By using life-cycle analyses, actors can assess the environmental performance of various options, such as using biomass for feedstock, packaging, construction material or fuel—which will further enable incentives for the best options. One possibility is developing sustainable (food) packaging, which, if supported and incentivised, could have multiple benefits, from reducing the import of plastics to producing higher-value material from biomass waste and residues. Another possibility is high-value cascading through biorefineries that allow for the production of sustainable chemicals.[253] The development of nutrient cascading chains for locally abundant products with high carbon sequestration potential can be prioritised at the same time: for instance. Linking materials flows from different industries, such as fractionated grass or food residues from urban areas to agriculture value chains, can result in higher-value animal feed and soil management. Noteworthy here is the existing *Resource Matching Service*,[254] which facilitates industrial symbiosis between different industries and companies. Revamping nutrient management at a regional level to produce secondary (recovered) raw materials and bio-based fertilising products holds the potential to cut the need for imported fertilisers.[255]

From a regulatory perspective, setting mandatory targets for the recovery of nutrients from slurries, manures and sludges would send a powerful message to the private sector that they must plan for the necessary investments in advanced, resource-efficient processes and the introduction of newer technology and infrastructure.[256] This could include low emission slurry-spreading equipment and means for more efficient storage of manure fertiliser, for example. Furthermore, nutrient recovery pathways are not necessarily incompatible with the sustainable production of biofuels, especially biogas through anaerobic digestion, as both biogas and a 'solid' nutrient-rich digestate can be recovered with this process. This digestate can in turn be used as input for bio-based fertiliser production or to enhance soil more generally.[257]

In the short-term, actors should aim to demonstrate the operability of on-farm nutrient recovery—as well as potential market applications. In the longer-term, Northern Ireland could look to significantly cut fertiliser imports to, instead, become an exporter of bio-based fertilisers.[258] These fertilisers should be comparable to standard chemical options—and attractively priced—to encourage farmers to embrace this change.[259] While this strategy presents a significant economic opportunity, it can also help Northern Ireland slash its agriculture-related nitrogen emissions.

Prioritise crop diversification to open up alternative lower-impact economic opportunities. To begin to explore bio-based materials and composites—which have synergies with other sectors, such as construction and manufacturing—Northern Ireland can consider ramping up its production of hemp. But government support and incentives, and public support will be needed. While knowledge of the material may be low within the private sector, the already-strong knowledge based in universities can be used to compensate—and to further incentivise open innovation and collaboration among actors. The country can also consider focusing on options for sustainable packaging: the food industry already has a strong local presence and is well-positioned to create technology and market-driven change. Additionally, well-planned afforestation schemes that increase the share of forested area in Northern Ireland can deliver long-term cumulative emissions mitigation,[260] while also opening up new economic opportunities. Moving to more mixed farming systems that improve the circularity and sustainability of Northern Ireland's food production would need strong policy support to give farmers the necessary confidence to change.

Facilitate a systems approach to enhance biodiversity, cut pollution and waste and increase sustainability. High-tech solutions that aim to reduce waste generation and pollution are valuable. For example, as the Independent Strategic Review of the Northern Ireland Agri-Food Sector (ISRAF) points out, digitalisation in the agricultural sector—through artificial intelligence applications, for example—can foster productivity, minimise waste, improve soil health and help predict extreme weather. However, data-related challenges are hindering the sector's digitalisation: farmers, for example, can be reluctant to share their data owing to a lack of understanding of how it'll be used and how it can help their business along with the sector. This can be tackled through the provision of a clear overview of potential economic benefits—expressed in terms of yield—to help illustrate how data can support and drive more sustainable farming practices.

Ultimately, ensuring long-term sustainability and productivity will require a shift away from intensive farming practices, towards low-input regenerative processes with crop diversification. Ensuring sustainable soil management through these practices can both slash the sector's emissions—helping it move towards net-zero—and crucially support biodiversity, regenerating natural capital.[261] While Northern Ireland's geography and other endowments dictate its ability to fully embrace regenerative agriculture, practices that enrich soil quality, reduce emissions and pollution, and improve biodiversity should be put into play at the greatest extent possible. Some current efforts—such as shifting farming subsidies from carbon sequestration to re-wetting bogs, restoring peatlands and planting native trees—are on the right track and should be scaled up.[262] In the future, a more detailed exploration of potential scenarios for the agri-food sector will be necessary to evaluate the technical and economic feasibility of measures for boosting Northern Ireland's circularity.

Cities will also have a key role to play in exploring synergies between advancing circularity in the built environment[263] and food production in urban areas.[264] Opportunities are abundant: from nature-based solutions[265] and green roofs[266] to vertical farming[267] and closed-loop production practices such as aquaponics.[268] If implemented carefully, these practices can offer environmental (increased biodiversity, cleaner air) and social (strengthened communities and greater resilience) benefits.

2. CONSTRUCTION

In Chapter four, Scenario two, we explored several strategies to advance the circular economy in Northern Ireland's built environment, from regulating building stock expansion, to bringing resource efficiency to the core of building construction and use, to increasing the occupancy of empty homes and commercial buildings. However, the strategies explored will require ancillary measures to maximise their potential—and overcome bottlenecks and barriers to implementation.

Carry out circular refurbishment and renovation practices. To optimise the use of the built environment, it will be crucial to carefully decide on the best strategies for refurbishing and renovating the existing housing stock[269]—while also increasing the occupancy of empty residential and commercial buildings. Policy should be designed to support the revival of vacant buildings of all kinds, through a change in pricing that incentivises refurbishment and renovation practices vis-a-vis new construction: the use of subsidies or fiscal instruments such as reduced VAT, for example, could be explored, while keeping an eye on behaviour-induced rebound effects to maximise benefits, for example regarding energy efficiency.[270] However, it's worth noting that limiting residential stock expansion without also regulating housing prices can cause serious market disruptions and potentially increase inequality by reducing the share of affordable housing stock.

Drive circularity in the private sector. From a business perspective, it's true that focusing on renovation activities will lead to numerous economic opportunities—but it's also important to keep in mind that many construction enterprises will need to adapt and compete for a smaller (construction) market. For this reason, builders must be incentivised and given knowledge of renovating and building for a sustainable future, with strict standards for emissions and material use. To fully maximise the potential of circularity and capitalise on environmental, economic and social benefits, companies will need to adapt and innovate. For example, investing in (partial) decarbonisation by replacing fossil-fuel based machinery and vehicles used in the construction sector with electric or low-carbon fuel alternatives (for example, biofuels and hydrogen). To track the progress of decarbonisation in the built environment over the long-term, industry-wide, standardised reporting methods for embodied carbon should also be approved and agreed on sooner rather than later.[271] Further innovation for business models like Product-as-a-Service and reuse will also be needed.[272] Finally, private sector actors will have to be retrained to acquire the new skills and competencies necessary to implement socio-technological innovations—such as digital tools like material passports and building information modelling (BIM), advanced deconstruction practices, and design for circularity principles.[273]

Raise awareness and support proactive stakeholder engagement. Only collective action through close collaboration can spark intra-industry change. Developing circular supply chains for the built environment will require a holistic and integrated approach with strong stakeholder engagement—to grow and make the secondary building materials market competitive, for example. This calls for close collaboration between stakeholders across the entire value chain, from architects, manufacturing companies, and designers to regulators and contractors. In this realm, certain tools exist to foster effective stakeholder engagement to promote collaboration across the whole value chain.[274] Ensuring standardisation, certification of origin, content, and quality is fundamental to realising such a market, as is close collaboration to ensure that education and training adequately accommodates new practices, from working with new materials to disassembling modular infrastructure. Northern Ireland is well-positioned to achieve this: it boasts plenty of collaboration programmes between business and academia across several areas. The public sector will have a fundamental and leading role bringing this to fruition, especially via policy support.

Give importance to design and urban planning and make circular design the standard design.[275] In construction and the built environment, long-term, systemic thinking and planning are key first steps for adopting circular design principles, through concepts such as modularity[276] and design for disassembly and deconstruction.[277] Such practices can be further aided by new circular business models, such as pre-agreed buy-backs and Product-as-a-Service schemes. Regulations, such as building requirements that increase the share of sustainably sourced and bio-based materials (timber, for example) and making demolition plans mandatory, will also play an instrumental role in incentivising change in the dismantling of buildings and in supporting greater innovation in material design and optimisation.[278] In addition, carefully-designed and well-intended circular

public procurement can send a clear message to the private sector: it's time to adapt and innovate to bring the circular economy to life. By practically applying circular economy principles and whole-life costing at the tendering stage,[279] circular public procurement can stimulate and drive demand for circular business models, secondary materials, and more sustainable building profiles and construction practices.[280] Scotland, for instance, has set up a Whole life costing tool[281] to calculate building and infrastructure lifetime costs and thus encourage improved design and long-term performance while cutting costs and energy use. Revamping the existing procurement scheme for sustainable construction and aligning already-existing funding programmes such as the City and Growth Deals, as well as the different stakeholders involved—especially the private sector—will be instrumental in achieving these objectives. Guidance, for instance, in the form of training programmes on circular construction,[282] will also be essential to inform building design (taking into account, for example, design for deconstruction or material recovery) and material choice (sustainable sourced, bio-based or secondary materials, for example). Access to accurate data and information on materials is essential to inform design, maintenance and reuse, which is why digital tools such as BIM and material passports should also be considered in the future.

3. ADVANCED MANUFACTURING

In Chapter four, Scenario three, we consider two main pathways that can help Northern Ireland shift towards a more circular advanced manufacturing sector. The first: maximise resource efficiency through improved industrial processes at all production stages (from early material formation to product manufacturing), to slash the need for metal inputs, narrowing flows. The second: implement various R-Strategies, such as remanufacturing, refurbishment and repair for machinery, equipment and vehicles in order to extend products' lifetimes, slowing resource flows as well as narrowing the flows of new virgin material inputs. In this section, we present some crucial recommendations for different stakeholders to advance circularity in Northern Ireland's manufacturing sector.

Leverage public policy as a crucial driver (for skills development). Updating current policies and existing regulations will be crucial for advancing resource efficiency: this can steer the private sector to rapidly implement changes that cut emissions and energy consumption, while driving resource security and productivity growth.[283] Critically, it should be considered how a waste hierarchy policy can be developed to maintain and optimise materials' value, by encouraging manufacturers to choose waste management options at the top of the hierarchy. Businesses may be incentivised to shift their focus away from end-of-life waste management—and, instead, place more emphasis on options such as designing waste out of early production stages, extending material lifetimes and choosing more durable materials, and considering strategies for reuse.[284] New and existing regulations can also play a major role in setting sector-specific (in this case related to the manufacturing industries) circularity targets that aim to reduce emissions, energy and resource consumption and increase overall productivity. This, in turn, will require robust measurement and assessment systems—as well as the development and adoption of circularity indicators that help to assess the circular performance of the sector and individual businesses. Policy could then be used to introduce new requirements for integrating circular considerations in decisions-making processes for production and manufacturing: conducting life cycle or other impact assessments, for example, or requiring circular reporting based on robust metrics and indicators that monitor progress against national targets.

Support manufacturing businesses in improving and increasing their circularity. True impact in terms of resource efficiency improvements and the implementation of R-strategies can be made if circularity is scaled up at the business level. Invest Northern Ireland's *Energy and Resource Efficiency Programme* comes into play in this context: the programme aims to support businesses through various interventions, including:

- **Specialist consultancy support** services, which include feasibility studies and audits to help manufacturers identify circular opportunities for resource efficiency improvement, cost-savings, carbon emissions reductions, waste management practices and packaging alternatives. Matrix, Northern Ireland's Science Industry Panel,[285] can also play a more active role in bringing circularity higher on the sector's agenda and advise on investments to be made by the public sector, and show how policymakers can help craft and enable market opportunities.
- **Investments:** It can be difficult for businesses, especially those within the manufacturing industry, to shift towards circular business models—often due to high investment costs and the time needed to make significant changes, such as retooling machinery or rethinking logistics and distribution.[286] Businesses can overcome this barrier and start adopting circular practices and models with financial support in the form of grants. For instance, the current Resource Efficiency Capital Grant support scheme allows businesses to apply for grants of up to €59,400 (£50,000) to fund the purchases of new equipment and technology developments aimed at improving water, energy and material efficiency in industrial processes. Such grants also align with policy goals as they act as incentives for businesses to adhere to the waste hierarchy previously described. Funds should not only involve circular businesses, but also engage universities and innovation centres, which play a key role in research and development for circular solutions in the manufacturing sector.
- **Circular business feasibility assessments**, which help identify new business models based on circular design, leasing and Product-as-a-Service models, R-strategies such as remanufacturing, repair and recycling, and reverse logistics. One example of such an assessment: a new business model that aimed to take back domestic oil tanks from household customers. Several options were assessed, from reprocessing the oil tanks to developing other products with the recovered materials.[287]

Set up pilot projects focused on increasing material productivity and efficiency. Industrial pilot projects offer support and demonstration for the uptake of new technologies, innovations and solutions—aimed at increasing material and resource productivity—to relevant businesses. Such projects also provide a means to mitigate implementation risk as they allow manufacturing companies to measure expected benefits and costs, and hence develop more robust business plans, and anticipate organisational and technical requirements associated with the circular transition.[288] At the EU level, a network of pilot de- and re-manufacturing plants for the circular economy is already in place. This aims to support the industrial uptake of innovative technological solutions and circular economy business models that can be implemented at an industrial level across different sectors. Northern Ireland and the UK in general could follow the example of such initiatives in order to encourage manufacturers (along with other industries) to scale innovative and efficient production processes. The Advanced Manufacturing Innovation Centre (AMIC), a combined academic and industrial expertise centre focused on promoting collaboration, can be tasked with identifying potential projects, offering expertise, and suggesting necessary budget allocation. AMIC can also serve as a launchpad after the completion of the pilot projects, applying learnings, scaling up and supporting wider adoption of innovations by disseminating knowledge and best practices.

Adopt the latest innovations in technology and resource management practices. This could refer to, for example, advanced waste management between manufacturing facilities (open loop) and within manufacturing facilities (closed loop). Industrial symbiosis—which goes beyond innovation for individual technologies or processes, but rather takes a systems approach—will be one of the most crucial approaches to adopt for long-term impact; as will the development of eco-industrial parks. Industrial symbiosis is intrinsically linked to the circular economy concept: it facilitates the creation of resource and knowledge synergies between industrial businesses, which allow them to recover and valorise unused resource flows (energy, water, gas, waste materials and by-products),[289] but also to exchange industrial and engineering expertise across different businesses.[290] Synergies vary widely: some are more focused on by-product and waste resource reuse between two or more businesses, as a substitute for virgin materials. In the context of eco-industrial parks, however, synergies can also stem from businesses sharing local infrastructure and utilities, such as water, energy and wastewater systems. By engaging in industrial symbiosis, advanced manufacturing companies in Northern Ireland could become more competitive and achieve significant improvements in terms of material and resource productivity and efficiency, while minimising the generation of unavoidable waste. The *Resource Matching Service* is a solid step in the right direction, to promote industrial symbiosis in the short term. But promoting and guiding proactive and close collaboration between actors will be key to structurally grow and sustain synergies. To this end, a fundamental factor for the long-term success of industrial symbiosis across different manufacturing companies is the development of a robust information system to keep track of resource flows, such as water, energy, materials, waste and by-products, in real-time.[291] For

this, Industry 4.0 technologies will play a key role, especially in the integration of data transparency, machine learning and artificial intelligence to optimise manufacturing processes and operations, and facilitate potential synergies.

4. TOURISM

The World Tourism Organisation defines sustainable tourism as tourism 'that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities'.[292] The horizontal, cross-cutting nature of the tourism sector means that making standalone recommendations to encourage and advance circularity is difficult. Actions needed to advance tourism's circularity will overlap strongly with other sectors such as construction, agriculture and mobility: some crucial measures in these realms have been addressed in Chapter four, in Scenarios one, two and four. The impact of promoting local tourism by the residents of Northern Ireland has also been explored in Scenario six. However, one question demands greater attention: what role can tourism play in a circular economy—and how can it best fit? Four levers are critical: 1) Correctly orientating the private sector (waste minimisation (food and packaging), maximisation of occupancy, energy efficiency of buildings, clean mobility); 2) Ensuring fiscal policies and economic instruments are appropriate; 3) Directly financing green tourism investments; and 4) Planning and development for green destinations. From this, we explore recommendations for raising awareness for opportunities, setting fit-for-purpose policy frameworks and profiling Northern Ireland as a sustainable tourism destination.

Raise awareness for key opportunities and set clear ambitions to increase and encourage sustainability in the sector. Firstly, Northern Ireland's government could set a clear strategic vision for the sector: this could include, for example, mandatory targets for waste reduction (for food and plastics) to be achieved by 2030 and then by 2050. To streamline their adoption, targets could be incorporated in the sector plans that will be required to achieve net-zero by 2050 as part of the climate change bill. Benchmarking will be crucial to provide the private sector with baseline measurements to work from and drive progress. This—coupled with clear visions and targets—will help stakeholders understand where they are and where they should be by 2030. More practically, pilot projects can be used to raise awareness, catalyse action among stakeholders, and demonstrate the economic benefits associated with circularity, such as cutting material, energy, water and waste costs. Such projects can span sectors: for **Food**, for example, pilots could stimulate farm-to-plate operations and encourage food waste reduction— by providing farmers with used cooking oil to fuel machinery or donating excess food to homeless shelters, for example. In the area of **Energy**, pilots could spur the adoption of environmental management and monitoring systems (for example, conducting energy audits and energy management programmes through the provision of smart metres) and ensure access to renewable energy, either on-site or through local energy companies (for example, by promoting the installation of solar photovoltaic and energy storage systems). Within the realm of **Water**, projects could seek to improve water management systems (for example, reusing greywater), and performing or utilising environmentally responsible laundry services (for example, efficient machines and non-toxic detergent). Finally, for **Circular management**, projects could drive the in-house adoption and implementation of a circular management system: for example, the review of food purchasing routines, and freezing and storage capacity.[294]

Develop a fit-for-purpose policy framework and infrastructure. Legislation and regulation will have an important role to play in advancing sustainable consumption and production patterns, in order to facilitate a resource-efficient tourism sector.[295] Levelling the playing field through financial and regulatory support will be crucial for circular business models, innovation through procurement and circular products and services to thrive. The ultimate aim—circular business models that are based on use rather than ownerships—will likely need economic incentives to get off the ground and expand. This can also ensure that profit—from restaurants, hotels and other accommodation, for example—can be reinvested into funding the better integration of technologies and solutions that advance circularity and sustainability in the sector. Companies running these business models[296] can distinguish themselves on the market as purpose-driven businesses that contribute positively to tourism. There is also ample opportunity to focus on direct green investment in infrastructure. Investments should promote cost-competitive alternatives to air travel—such as ferry services—to connect Northern Ireland to the mainland UK, and should promote sustainable integrated infrastructure, transport and mobility options in both urban and rural areas.[297] Public investment in infrastructure can also be channelled towards activities that incentivise change, such as common composting facilities, community gardens and upcycling and repair centres—for furniture and business equipment, for example.

Design, plan and develop the environmental profile of Northern Ireland as a sustainable tourist destination. Northern Ireland can be positioned as an attractive destination for new demand-side trends in the industry. Consider stimulating a tourism model in the country rooted in sustainable practices, such as 'slow travel', eco-tourism and 'live like a local'. Ensuring that close interaction and engagement is maintained across the entire supply chain is important to achieve these goals: the key to achieving an integrated circular touristic ecosystem is ultimately underpinned by close stakeholder collaboration—between purpose-driven business models, technology and service suppliers, sustainably-minded customers, farmers, and a fully functioning sharing economy for accommodation. The government can proactively organise, lead and guide stakeholder engagement.

MATERIAL STREAMS

5. CONSUMABLES: TEXTILES, ELECTRONICS, & PACKAGING

Chapter four's final Scenario illustrates the potential impact of a 'material sufficiency' lifestyle: a reimagining of our relationship to 'stuff', consumables like textiles, electronics and packaging, as well as our relationships with our communities. These goods also represent three of the four material streams prioritised by the Department for the Economy. In this section, we go beyond the strategies explored in Chapter four and present five key recommendations for change.

Develop a fit-for-purpose policy framework. Legislators are key market participants with the power to guide and accelerate action. Their actions can have a massive impact in preventing waste: the introduction of requirements or standards obliging electronics and textiles producers to provide repair services, for example, can substantially extend product lifetimes. One such measure is Extended Producer Responsibility (EPR) regulation: these policy instruments can be adopted to incentivise producers—and hold them accountable—to provide more appropriate repair and refurbishment services, and to avoid non-reusable, non-recyclable materials in the design and production of textiles, packaging and electronic goods.[298] Life-cycle thinking and metrics for product circularity (such as eco-labelling, material efficiency standards, lifetime extension and waste reduction) can also be used to guide the development of policy targets, and can benefit production and consumption market dynamics.[299] Doing so will further serve to mainstream the purchase and use of circular clothing and electronics that have been either reused, repaired, recycled or refurbished. By labelling these products, companies can show transparency and give consumers a better indication of which products to look for. For example, in the case of electronics, stronger policy support in the short-term in the form of stricter eco-design criteria, 'right to repair' legislation, and stricter end-of-life regulations to support the development of new business models are crucial policy instruments to advance circularity.[300] For maximum effectiveness, this should take place on a UK-wide level. Tax reductions or exemptions, for example on VAT, may also be rolled out to encourage consumers to 'shop circular'—while tax reductions for labour in the reuse, repair and remanufacturing

sectors can also work to mainstream these activities in the medium-term.[301] Some initiatives are already being introduced that could be built upon further: the plastic packaging tax, introduced April 2022 in the UK,[302] will impose a fee for plastic packaging with less than 30% recycled content. This could be made even more ambitious, and increased to 100%. Finally, command-and-control policy instruments—such as a ban on the export of textile, plastic and electronic waste[303]—could encourage domestic reuse, recycling and repair activities while preventing waste exports to lower-income countries with lower safety standards and more informal waste management systems. Impact assessments, such as those carried out for single-use plastics, can guide policymakers in determining potential policy impacts of the introduction of different instruments to steer the consumption of other products in Northern Ireland.[304]

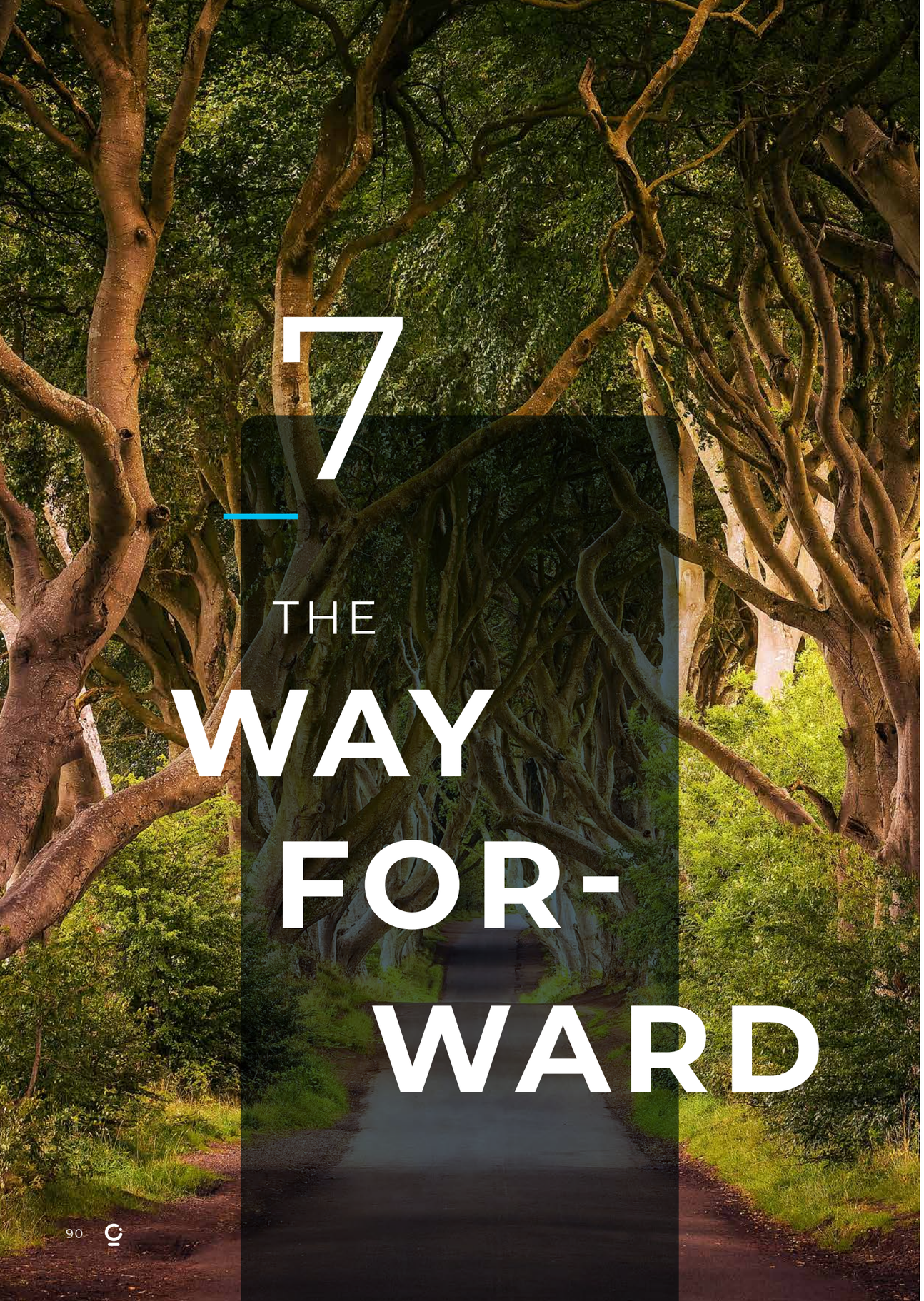
Create strong guidelines for circular public procurement. Guidelines and processes may be adjusted to effectively drive the transition to a circular economy. The government may consider incentivising the procurement of products designed with circularity in mind, for example, which may include short-term features such as sustainable packaging certification programmes (C2C, for example), product and material eco-labelling, modularity, repairability, recyclability and more. Effective guidelines should make a long-term commitment to a well-defined goal: increasing the percentage of the budget to be spent on circular products, for example, based on criteria like sustainable sourcing, the proportion of recycled content (particularly for electronics and packaging) and renewable, bio-based content (particularly for textiles and packaging), and the proportion of refurbished electronic equipment used in public buildings. EU Life+ partnership project REBus could provide a good starting point: led by UK-based WRAP and the Dutch Ministry of Infrastructure and Water Management, the project supports and guides government bodies in piloting circular procurement processes across the UK and the Netherlands, addressing a number of sectors—electronics and textiles among them.[305] In line with examples given elsewhere, another avenue could be to set up a procurement centre to structurally ingrain sustainability into tendering processes and support demand-led innovation.[306] This could also serve as a platform for capacity-building, the dissemination of knowledge and the exchange of ideas and best practices.

Invest in order to scale up and upgrade infrastructure. Improved infrastructure will be crucial to boost the collection, recycling and recovery of valuable materials from discarded consumer goods.[307] If sorting and pre-processing are optimised, valuable components from electronics and various textile and packaging materials—such as fibres, cotton and plastics[308]—can be recycled to the greatest extent possible. However, doing so will require the short-term adoption of technological improvements for earlier processes—such as collection, sorting and handling—to ensure that later steps like repair, refurbishment and recycling go smoothly.[309] Here, minimising unavoidable waste—especially the toxic waste present in electronic goods—will also be essential. Boosting material and product reuse will necessitate the formation of take-back infrastructure: digital or physical platforms can both be created to help expand the market for secondary materials, and balance and connect the supply and demand of recycled and recyclable materials, such as second-hand clothes[310] and electronic devices.[311] If done in an automated and optimised way, this can also help create symbiosis with other industries—electronic goods and advanced manufacturing, for example. In the case of electronics in particular, the UK is missing the tremendous economic potential of recovering critical raw materials due to a lack of advanced recovery infrastructure and technologies.[312] Establishing an infrastructure investment fund for electronic waste underpinned by short-term and longer-term investment impacts to increase capacity and capability could be considered.[313] All in all, scaling up the necessary infrastructure may be better done through a holistic, UK-wide approach: this could create more stakeholder engagement and therefore result in even greater recycling and sorting capacity, while creating new job opportunities. Aside from improvements in physical infrastructure, recycling and reprocessing facilities will also need to undergo changes in supply chain management to maximise efficiency in the long term.[314]

Promote a cultural shift. As addressed in Chapter four, shifting cultural norms and behaviours surrounding consumerism will be critical for Northern Ireland to cut its material use and boost circularity. The environmental impact of overconsumption across sectors isn't necessarily well-known: awareness raising will be needed to instil more conscious behaviours in the consumption, use and end-of-life phases of goods. If this comes to fruition, it could have a substantial impact on the scope and timing of the circular transition. Consumers of fast fashion, for example, have the potential to make a huge impact: their choices influence the success and speed of transformations due to the quick-cycled nature of the clothing industry.[315] Raising awareness for the problems electronic waste can bring[316]—such as supply risks for finite critical materials and toxic materials, as well as health issues due to extraction sites' poor working conditions—should also be a top priority. In fact, for all consumables (but for electronics in particular, given they are the fastest growing waste stream in the UK) forming new consumption patterns by shifting public perceptions and attitudes, through effective public awareness campaigns, are key.[317] Consumers should also be encouraged to shift away from purchasing products that are systematically plastic-packaged—especially those with packaging design that hinders recyclability.

Creating circular marketplaces—both physical and online—are also a crucial part of facilitating a cultural shift and ingraining circularity in everyday habits and norms. Consumers may be more willing to shop second-hand if they're presented with reliable online marketplaces for used garments or refurbished electronics, with decent warranty policies and personalised customer service. Physical spaces that espouse circular values—such as second-hand shops and repair cafés—can also bolster a sense of community and drive acceptance for circularity, resulting in more conscious and meaningful purchasing habits.318 Of course, it must be noted that aligning individual consumer choices with sustainable values is only part of the solution: the biggest part of the action must be driven by industry, business and government.

Diversify and create new circular business models. Producers for all consumables will have a lot to consider in shifting to circularity: they'll need to consider where they're sourcing their materials, how they're designing their products, and who will be held accountable for the end-of-life management of their products. This will give rise to a range of new career opportunities and business models. Circular product and material design consultancies, for example, may be needed to advise on circular design, material type, packaging and more, while production and manufacturing companies specialised in handling and producing goods with recycled and renewable materials may increasingly crop up. Reverse logistics companies will be important for the take-back and collection of consumables, as will companies specialised in repair, recycling and remanufacturing activities.[319] Finally, supporting business models that provide electronics-as-a-service—or develop leasing schemes for electronic goods[320]—will also be crucial, in addition to digital and physical shops for second-hand goods.



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THE WAY FOR-WARD

Northern Ireland has the potential to transform its economy: by doubling its circularity, it can halve the resources needed to fulfil its residents' needs and wants. This report illustrates how resources are allocated to meet Northern Ireland's needs and wants—and lays out guidelines for how the country can drive its circularity from 7.9% to 16.1%. This increase may not seem huge—but doing so will cut the material footprint by 48%, bringing substantial positive impact for the climate, biodiversity and pollution. This will also bring Northern Ireland's circularity nearly in line with the global average needed to limit global warming to 1.5-degrees and prevent the worst impacts of climate breakdown. Our seven scenarios provide Northern Ireland with an opportunity to overhaul its economy, and swap out resource- and emissions-intensive linear processes for ones that make the most of materials' value, minimise waste, and help regenerate natural systems: a transformation to circularity.

This shift will not be easy—nor will it take place overnight. The strategies presented in Chapter four have transformative potential—but their implementation will be met by numerous challenges. While shifting to a plant-based diet could have a greater impact on the country's material footprint than all interventions for the built environment combined, the massive role of intensive animal agriculture in Northern Ireland's economy cannot be overlooked—a shift of this magnitude would turn the agricultural sector on its head and would therefore require careful planning and a more gradual shift towards less intensive and more plant-based production. And on the other side of the scale, interventions that don't present obvious quantifiable benefits (such as those for circular manufacturing) may be difficult to realise, as disruptive change must beget more-than-modest gains—despite the tremendous economic potential, in terms of resilience and jobs, behind them.

Jobs will have a critical role to play in the transition. By shifting to a circular economy, it is expected that the type of roles undertaken will be reshaped: new jobs will be created and existing ones transformed. As Northern Ireland is facing ongoing critical challenges for the labour market—such as low levels of productivity and low skills levels among adults—work and workers will require close attention through the transition to a circular economy to ensure that livelihoods are improved as Northern Ireland leaves linear behind. There's still a way to go, as only one-tenth of workers currently boast jobs that either directly or indirectly support circularity. Everyone has a part to play: the vast majority of these jobs are generated by sectors that indirectly support the circular economy—meaning that as we move toward a circular future, any worker in any sector can contribute.

Change must come, but current solutions are grossly inadequate for the challenges we face today. Our natural environment has been stretched to its breaking point—and this is only set to continue as global income and population continue to swell. The trajectory of human history—and our current linear system—have served to shine a light on how affluence is tightly linked to material use (and consequently, to waste generation and emissions).[321,322] It doesn't have to be this way: Northern Ireland can meet the needs of its people within planetary boundaries. Transitioning to a circular economy can bring the per capita material footprint down from 16.6 tonnes to 8.3 tonnes per person: in line with recommendations for a 'sustainable' European nation. But this will require more than just boosting resource efficiency: it calls for a radical transformation of how Northern Ireland extracts, transforms, uses and disposes of its resources. Transitioning to a circular economy isn't a silver bullet—but it is a crucial first step, with shining potential.

All countries are critical change agents. The global economy is just 8.6% circular: linearity is embedded in societies worldwide, and especially in the *Shift* country profile of which Northern Ireland is a part. While this report takes a national perspective on circularity, it is crucial to recognise Northern Ireland's position in the regional and global context. With moderately high levels of extraction (non-metallic minerals and biomass, in particular) and consumption, and prosperous living conditions for its residents, Northern Ireland has a strong responsibility as a player on the global market to drive circularity and cut its ecological impact. This can extend beyond its own borders: as an agricultural powerhouse with an export-driven sector, Northern Ireland could impact the sustainability of other countries by increasing, over time, its export share of plant-based, organic foods grown with regenerative agricultural principles in mind, for example. At the same time, it could leverage its abundant local resources—such as minerals and biomass—to satisfy its own needs rather than relying on imports with hard-to-control circularity. And as extractive operations are largely carried out to satisfy demand abroad, ensuring these processes are managed more sustainably could have a crucial global impact. It's time for Northern Ireland to leverage this opportunity, while raising the material-use agenda on par with emissions-reductions targets.

A huge opportunity for Northern Ireland. While the country exhibits levels of consumption and extraction that far surpass the global average, it's well-positioned to take on the challenge of going circular. With well-formed goals for decarbonisation and the circular economy widely accepted as a means for economic development within the political landscape, Northern Ireland has already taken its first steps to leave linear behind. Proactive stakeholder engagement will be key to the transition's success—and with plenty of collaboration programmes between business and academia that span sectors, Northern Ireland has the foundation needed for circularity to succeed. Through close collaboration and systemic changes that permeate government, the private sector and individuals, 'going circular' can become the country's new reality.

THREE STEPS TO BRIDGE THE CIRCULARITY GAP THROUGH LEADERSHIP AND ACTION

1. Drive national progress toward circularity with metrics and goals. Our analysis demonstrates the complexity of Northern Ireland's economy and has made clear where linear conduct is embedded; these can be focus areas. Practical pathways that are aligned to the local context, incentives and mandates are crucial. Northern Ireland must also set goals to keep its progress thoroughly on track and measurable. The Metric also presents a measurement of progress toward a circular economy which can be revised, as does the material footprint, but to make progress actionable and focused, Northern Ireland should improve its waste data collection, compilation and harmonisation process to ensure robustness and enable progress tracking.
2. Ensure a national coalition for action is both diverse and citizen-centric. This will bring together frontrunning businesses, governments, NGOs and academics to collectively boost capacity and capability to serve societal needs and wants more sustainably. It will work to ensure that citizens and consumers are actively involved with circular economic activities. A national circular economy can be fully supported and realised if avenues facilitating consumer consumption become more circular.
3. Strengthen regional and global knowledge and pace toward circularity and consumption reduction. Northern Ireland can learn a lot from other country's national journeys toward circularity. Peer-to-peer learning and knowledge transfer will increase the pace towards global circularity. In this sense, there are opportunities for close collaboration with other UK regions such as Scotland as well as with the Republic of Ireland in a 'shared island' approach, by establishing knowledge-sharing relationships to explore synergies and exchange key learnings and best practices, for example through the Irish Government's part-funded Shared Island Fund. When it comes to the circular economy, we all still have a lot to learn.

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ACKNOWLEDGEMENTS

Circle Economy would like to thank the funder, authors, contributors and interviewees for their contribution to the preparation of this edition of the *Circularity Gap Report* Northern Ireland. Authors and contributors and interviewees have contributed to the report in their individual capacities. Their affiliations are only mentioned for identification purposes.

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DESIGN & LAYOUT

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Version 1.0 (May 2022)

circularity-gap.world