The Irish Climate Tech Opportunity 2023

sustainability works

pwc

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Foreword

Dear reader,

The stark messaging from the InterGovernmental Panel on Climate Change remains unchanged, "this is a code red for humanity". The impact of climate change is clear and can no longer be ignored nor viewed as someone else's problem. Climate targets have been set and these mustn't be seen as "aspirational" but rather, as a deadline for humanity.

I firmly believe that technology and innovation will be critical to accelerate the pace towards Net Zero. Recognising the global opportunity to decarbonise, Irish entrepreneurs are already delivering Climate Tech solutions to local and international customers. This report provides a glimpse into the strength of the existing Irish Climate Tech sector and the surrounding ecosystem that supports it.

While there are firm foundations, there's more to be done. In particular, we need a "one-stop-shop" here in Ireland that will enable entrepreneurs, investors, researchers, government and corporates to come together and work on this shared agenda. If Ireland truly wants to be part of the Climate Tech innovation wave, the time is now.

SustainabilityWorks were a clear choice of partner in our endeavour to bring visibility to the Climate Tech ecosystem. Their wealth of knowledge and experience within the sustainability sphere has been invaluable to the project. I'm particularly delighted that one of the authors is Aideen O'Hora who has been central to the development of Ireland's Climate Tech ecosystem over the last decade. I'm excited to collaborate with SustainabilityWorks on future projects as I've no doubt that there is a lot more to be done to promote and expand Ireland's Climate Tech ecosystem.

This is only the beginning of the Irish Climate Tech opportunity.

David McGee, PwC

Dear reader

This report provides a comprehensive overview of the Climate Tech ecosystem in Ireland, showcasing great Irish entrepreneurs scaling their businesses nationally and internationally. The purpose of the report is to highlight the challenges and the opportunities for these businesses, and we identify urgent actions to position Ireland Inc to take advantage of this commercial opportunity as the world transitions to a low carbon, circular economy. We highlight Denmark's State of Green as an exemplar of what Ireland could do.

So much about climate change is negatively framed and focuses on risk. In our work, we seek to flip this narrative as we believe that the transition to a cleaner, greener world is an opportunity, not just a burden. Climate Tech innovation is a perfect example; as it can engage the business and finance community to act on climate change in a way that is aligned with commercial objectives.

This topic is close to our hearts as our co-founder, Aideen O'Hora, has been at the heart of the development of the Irish Climate Tech ecosystem over the past decade. She championed the development of Ireland's first cleantech report in 2014. She established Ireland's first Climate Tech accelerator in 2017 and continues to support and mentor start-ups from Ireland and across Europe with EIT Climate-KIC, Europe's leading climate innovation initiative.

We were delighted to find like-minded partners in PwC who shared our vision for Climate Tech in Ireland. Together, we look forward to delivering on this opportunity for Ireland Inc.

Aideen O'Hora & Laura Heuston, SustainabilityWorks

Introduction

> "A global climate catastrophe will be really bad for business. Preventing that catastrophe is possibly the largest investment opportunity in human history as it involves innovating and improving almost everything."
>
> **Bill Liao**, General Partner, SOSV

The greatest innovation challenge humankind has ever seen

PwC's 2022 Net Zero Economy Index found that to keep global warming at or below 1.5°C, the world must now decarbonise at a rate of 15.2% per year. This is 11 times the rate historically achieved – 1.4% over the past two decades.[1]

According to the 2022 UN Emissions Gap report, current policies point to a 2.8°C rise in temperatures by the end of the century.[2] The stark messaging from the InterGovernmental Panel on Climate Change (IPCC) remains unchanged: this is a "code red for humanity".

While this is arguably humankind's greatest ever challenge, with just seven years to halve global greenhouse gas (GHG) emissions and until 2050 to reach net zero, it is also our greatest innovation opportunity.

Faced with a potentially existential crisis, society must innovate urgently and at scale.

The rise of climate entrepreneurship

COP27 and Climate Week NYC 2022 highlighted the increasing recognition that a new generation of innovators will play a critical role in accelerating decarbonisation by delivering solutions and business models that have the potential to radically decarbonise carbon-intensive sectors, particularly the transport, energy, industry and food sectors.

For these start-ups, the challenge is how to scale up. Access to a supportive ecosystem, which includes funding, supports and partnerships, will be critical to success.

Climate Tech is defined as technologies that are explicitly focused on reducing GHG emissions or addressing the impacts of climate change.[3] Climate Tech applications can be grouped into three broad, sector-agnostic groups:

1. Those that directly mitigate or remove emissions
2. Those that help us adapt to the impacts of climate change
3. Those that enhance our understanding of the climate.

Maturing investor interest

While the overall Venture Capital (VC) market has seen a significant decline over the last year, the decline in Climate Tech investment has been markedly less. VC funding in Climate Tech has totalled US$52bn over the first three quarters of 2022 – 30% less than the same period in 2021.[4] However, investors remain optimistic for the market, with eight in ten respondents planning to increase their investment in environmental, social and governance (ESG) products over the next two years.[5] With the backdrop of war in Europe, inflation, and a sharp correction in the capital markets, Climate Tech markets have shown encouraging resilience in the face of its first real test since the notorious boom-and-bust era in the early 2000's.
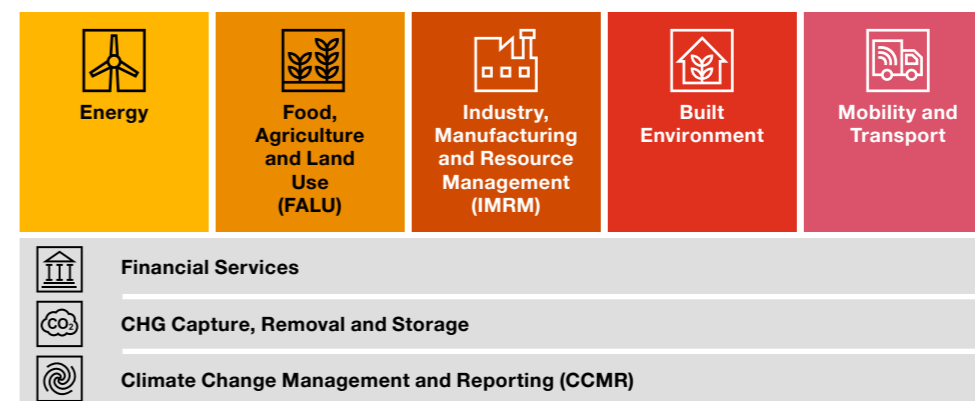
Critically, however, the number and total value of small deals – typically at the earliest stages of funding – have consistently shrunk since the start of 2021. This has led to a deficit in funding for the next wave of Climate Tech success stories.[4] To meet climate objectives, more investment is needed and must be primarily focused on two areas: first, on early-stage funding and second, on technologies with the highest potential for reducing emissions.

All funders will have a continued role to play, including angel investors backing new entrepreneurs and VC playing a catalytic role. Alongside this, there is a need for climate-led 'patient capital' investors – to set the direction for long-term investment into climate innovation.

Strong demand signals

Globally, demand signals for Climate Tech solutions look strong from both the public and the private sectors. Policymakers are increasingly connecting the dots between climate security, energy security and economic security. By communicating climate initiatives in the context of both the economy and society, they can increase public support. This is especially evident in the current energy crisis.

The private sector is also focusing on the time value of carbon[5] which balances near-term net zero levers with the development of long-term solutions to mitigate emissions. For the latter, initiatives like the **First Movers Coalition** (**link**) and **the Science Based Targets initiative** (**link**) have emerged to strengthen the demand signals from the private sector for Climate Tech solutions, which in turn allows investors to fund the scaling up of emerging start-up solutions.

Energy	Food, Agriculture and Land Use (FALU)	Industry, Manufacturing and Resource Management (IMRM)	Built Environment	Mobility and Transport

	Financial Services
	CHG Capture, Removal and Storage
	Climate Change Management and Reporting (CCMR)

The Climate Tech landscape

The term Climate Tech is broad in order to incorporate the many technologies and innovations used to address GHG emissions and the wide array of industries in which they are applied. This report considers Climate Tech in relation to opportunities for climate action within five sector verticals and three cross-cutting horizontals. These areas broadly follow the industry classifications set out by the IPCC, which are typically used when discussing emissions reduction.

Irish Climate Tech is maturing

There is growing confidence in the Irish Climate Tech sector, evidenced by the establishment of new funds with a climate focus and the emergence of innovative companies. An Irish Impact Innovation 2022 report by TechIreland and Wake Up Capital (**link**) showed that on average impact innovators are more likely to attract investment and have raised larger investment sizes compared to a few other leading clusters in Irish tech.[6] This confidence has not evolved in a vacuum. Over the past decade, several innovation clusters, accelerator programmes, research bodies, and Government funding and investment programmes have focused on supporting and showcasing Irish Climate Tech innovation. European and national policy and regulation has given market signals to the energy sector, making it the most mature sector in Ireland today. We are now seeing policy expanding to support other areas, including the circular economy, sustainable food systems and food security and the need to have green buildings. With this, we see a new wave of pioneering entrepreneurs.

While there are firm foundations, there's more to be done if we are to meet the country's net zero target. Not least, we need to nurture a pipeline of climate tech companies from very early stage to mature. More focused policy, initiatives and funding are needed to ensure that such sectors survive and thrive

The time is now

This report looks at the Irish Climate Tech ecosystem along with some examples of innovative Irish Climate Tech companies, with the aim to:

» Build **confidence** in the sector. There is a thriving and dynamic Climate Tech sector in Ireland providing solutions for Irish and global customers.

» Create a sense of **urgency**. Regulation, policy (both European and domestic) and the market are giving demand signals for Irish Climate Tech solutions, but there is room to strengthen these signals.

» Encourage unhindered **capital flows**. Public and private investment in Climate Tech is growing, but it should no longer be considered niche. Rather, it must become the norm.

As a leading innovation hub, Ireland knows how to create supportive ecosystems and partnerships that can further generate, incubate and accelerate innovation. The urgency of climate change means it is now or never. If Ireland truly wants to be part of the Climate Tech innovation wave, the time is now.

Calls to action

Three critical actions emerged in the formation of this report:

» Initiated by the Government of Ireland but supported by the private sector, Ireland needs an equivalent of **State of Green** (**link**), the initiative of the Danish government. Creating a one-stop-shop for the entire ecosystem – allowing entrepreneurs, regulators and investors to come together – while providing a showcase for customers, will bring the opportunity to the next level.

» To create greater urgency, there needs to be stronger demand signals to the market. This includes both government signals through climate and carbon policies, incentives and green procurement as well as companies developing plans to act on their decarbonisation commitments.

» The sector needs more capital of all types. Capital will flow based on awareness and the fiscal environment. Our next briefing will provide in-depth insights into the Irish investment landscape and how we can attract a greater flow of capital.

Ireland's Climate Tech ecosystem: a hidden asset

Ireland has a rich Climate Tech ecosystem. At its heart are passionate entrepreneurs on a mission to decarbonise the global economy. However, they do not exist in a bubble. There are broad and diverse stakeholder groups that are key partners in scaffolding their innovative ideas.

The Irish Climate Tech ecosystem

MIT[7] research has identified five key stakeholders critical to the success of the creation of an innovation ecosystem: entrepreneurs, government, corporates, universities and risk capital. The following ecosystem map defines these stakeholder groups and provides examples of the players in Ireland today.

It should be noted that the companies included below are neither exhaustive nor exclusive, rather intended to give insight into the existing and exciting Climate Tech ecosystem and the opportunities in Ireland.

The government

www.mygiig.eu

Food, Agriculture and Land Use (FALU)

The universities

Energy

SUPERNODE™
Connecting the Future

GlasPort Bio

the NATURE TRUST

DOWMANN

biowave TECHNOLOGIES

ElectroRoute

HEXAFLY
Sustainable Natural Contribution

SENOPTICA
TECHNOLOGIES

XOCEAN
Ocean data, delivered.

energycloud

MAGROWTEC
MAKING MORE OF LESS

FoodCloud

positive carbon

GREEN REBEL

SKYSPECS

The Climate Tech innovators

Shown are some examples of innovator companies in this space which are included within the report

Mobility and Transport

Industry, Manufacturing and Resource Management (IMRM)

Verifact.
Helping you join the dots

Built Environment

TERRATONICS

cityswift

CoolPlanet

VorTech

BERWOW

Ohme

PALTECH
Polymer Alloy Technology

ACTIONZERO

Symphony

GAMMA
Locate, Analyse, Predict

ne

AMCS

Sensi

KelTech IoE
THE NET ZERO NETWORK

RetroKit

ecocem

SMART FLOW

The capital providers

zeronet
A World Beyond Waste

concrete 4change

The corporates

The government

Representatives can come from the various Government departments or state agencies, or indeed from elected officials. The term should also be taken to refer to policies, national programmes, grants, and other funding sources.

The universities

Provide a range of different activities and insights for the innovation ecosystem, including the commercialisation of Climate Tech academic research. Also include most incubator or accelerator type programmes.

The capital providers

Include venture capital (VC), critical climate-led "patient capital" and public-private blended sources of capital.

The corporates

Contribute through 'on-the-job' talent development, risk capital through their 'corporate VC' arm, their facilities that support innovation, infra & their convening power.

For a comprehensive list of ecosystem stakeholder groups, please visit this page (link)

Energy

The global opportunity

While the production, transport and use of energy make up almost three-quarters of global GHG emissions, much of these emissions can be meaningfully attributed to other sectors.[8] GHG emissions that are attributable to the production of energy, including fugitive emissions, represent 12% of global emissions. This sector represents one of the greatest opportunity areas for Climate Tech. The rapid growth of mature technologies, such as wind and solar, has shown the potential of clean energy technologies to reduce emissions. Net zero emissions will require far greater scale, and will be enabled by the development and mass rollout of other clean energy solutions at an earlier stage of development, such as hydrogen and carbon capture.[9] Energy storage and more efficient smart grids will also be required to support innovation, the scale-up of renewables, and the transition to e-mobility.

In Ireland

In Ireland, the energy sector has traditionally been the most popular with entrepreneurs and investors, being largely driven by European and Irish climate and energy policy and regulation. Recent issues in relation to energy security are also creating market demand for new solutions. However, there is still scope to do more, such as nurturing development opportunities in offshore renewable energy and the decarbonisation of heat (for example, through the possible expansion of innovation around our natural geothermal resources).

Global emissions share

12%

(2019 data) [10]

Irish emissions share

15.8%

(2019 data) *

* Source: EPA, **Ireland's Provisional Greenhouse Gas Emissions 1990-2019**, viewed on 12/12/2022 (**link**)

On the horizon >

Blue and green hydrogen have potential as an alternative fuel source. The **European Union's Fit for 55 hydrogen strategy** (**link**) is accelerating the rollout of hydrogen infrastructure in Europe and growing the interest in green hydrogen start-ups. The EU ReFuelEU Aviation sustainable aviation fuel initiative is also attracting attention.

> " Ireland has the greatest per capita opportunity for biogas production compared to other European countries given our extensive agriculture sector."
>
> **Ken McGrath, Co-Founder and CEO of Biowave Technologies**

Alternative fuels

Opportunities for innovation include the production, development and distribution of alternative fuels, including biogas and blue and green hydrogen.

Waterford-based **Biowave Technologies** (**link**) are focused on solving the challenges with "hard to break down but huge energy potential" waste (including dairy sludge) to transform it into renewable biogas. Their process uses electromagnetic microwave radiation to efficiently heat the waste and convert it into a product that is an ideal feedstock for biogas production.

Simply put, this means significant amounts of renewable energy in less time. Experiments on the technology began in 2008 and have been funded through EU and Irish grant programmes, including the Enterprise Ireland Disruptive Innovation Technology Fund. Co-founder and CEO of Biowave Technologies, Ken McGrath, is hopeful for the future as he believes that "the RepowerEU action plan will massively scale-up biomethane production in the EU by 2030".

Another company focused on scaling up biogas production in Ireland and the EU is **MyGug** (**link**). Supported by Cork's Local Enterprise Office, the start-up is developing micro-scale anaerobic digesters, which convert food waste into biogas for both residential and commercial use. Despite micro-scale digesters being more common in hotter climates, Kieran Coffey (mechanical engineer and founder) has been able to replicate the high temperatures required for the process to perform in Ireland within their egg-shaped product. Macerated food waste is pumped into the egg digester and, following digestion the resulting biogas is stored in outdoor gas bags, ready for use in the kitchen. The micro-digester is already achieving gas savings in households and small food business settings.

Renewable energy

Opportunities for innovation include measures that support the proliferation of renewable energy across the supply chain, including load balancing (storage), supply-demand balancing mechanisms and enabling data collection technologies.

Founded in early 2017, ocean data company **XOCEAN** (**link**) now has offices in six countries across three continents. Continued growth of the global ocean economy in areas such as clean energy and decarbonisation projects is driving the need for high-quality data to enable informed decisions. However, ocean data has traditionally been acquired using large, crewed vessels that emit substantial amounts of carbon. XOCEAN instead uses Unmanned Surface Vessels (USVs) that are controlled remotely, minimising both the impact of their vessels on the surrounding environment and also the associated carbon emissions. Employing over 190 people, the Louth-based company provides data services to surveyors, companies and government agencies around the world. XOCEAN has received large amounts of investment to date, including €8mn of investment from VentureWave Capital in 2021,[11] enabling them to scale and meet the growing demand for their services.

Another company that has recognised the opportunity to service the growing offshore wind sector is **Green Rebel** (**link**), headquartered in Cork. Following a town-hall meeting in Ballycotton about offshore development, entrepreneur Pearse Flynn saw an opportunity to build a local supply chain network within Ireland that would accelerate offshore wind development, similar to that of Scotland. Established in 2020, Green Rebel has built technology and data acquisition capabilities to support and de-risk offshore wind farm developments through the surveying and screening of seabeds and marine ecosystems. Green Rebel recently announced their new floating LiDAR (light detection and ranging) platform. Designed in Ireland, the purpose-built platform delivers more reliable wind resource data up to 300m above sea level, reducing some of the uncertainty associated with wind farm investment.

> " The sea bed is constantly changing so this data needs to be continuously updated. Our Unmanned Surface Vessels can operate and collect data on a 24/7 basis."
>
> **Karen May**, CFO of XOCEAN

> " If the curtailed wind energy in 2019 had been redeployed to heat hot water in homes, this could have displaced 145,337 tonnes of CO_2, avoided €5.8mn in carbon penalties to Ireland and €45mn in fuel bills to householders."
>
> **Derek Roddy**, Co-Founder, EnergyCloud

Increasing the efficiency of the energy sector

Opportunities for innovation include measures that increase the efficiency of the energy sector, including the energy grid, or of energy-intensive consumers such as data centres while reducing associated GHG emissions.

Founded in 2020, **EnergyCloud** (**link**) is an innovative social enterprise that aims to divert otherwise wasted Irish wind energy into Irish homes. With a background in energy and technology, Derek Roddy (co-founder) saw an opportunity to leverage **FoodCloud's** (**link**) surplus food redistribution model and "redistribute surplus energy to people in fuel poverty". Surplus wind energy occurs when more wind energy is created than the grid can handle. EnergyCloud's solution is to redeploy this surplus renewable energy to heat hot water tanks in Irish homes for free through a remote switch on the household's immersion. Supported by Wind Energy Ireland and the Irish utilities sector, EnergyCloud is currently piloting the technology with Clúid Housing association. Recognising that this is not solely an Irish issue, they believe there is an opportunity to share their solution internationally and engage in global action.

Founded in 2018, **SuperNode** (**link**) is a global technology company developing transmission technology for the energy grid. Recognising the significant limitations in the capacity of the current grid, as well as the inability of copper to transmit energy at scale, experienced entrepreneur Eddie O'Connor sought to identify an alternative material to transmit energy through the grid. "Going back 20 years, Eddie has had a vision for a cross-border supergrid in Europe that functions as a single, free electricity market by capturing the variability between the sun and the wind".[13] The SuperNode team recognised the potential of superconductors to carry huge amounts of power while requiring significantly less infrastructure, materials and space. However, some of their biggest challenges include raising awareness of their technology and the need for regulation. The team is currently developing superconducting cables at the company's Dublin base, aiming to pilot the technology from 2025 onwards.

ElectroRoute (**link**), is an international, renewables-focused energy trading and services company, which was established in 2011. The founders identified early on that independent renewable assets would need access to a trading capability to trade energy at scale. Without these services, these assets would be able to do little except sell power to utilities, which could impact innovation and flexibility in the sector. In recognising the need for a robust and reliable system, the founders developed an energy trading and risk management platform underpinned by machine learning and advanced data analytics. Being a new approach and concept at the time, the founders targeted energy investors who understood the platform's potential. The company has since been acquired by Mitsubishi Corporation[14] and grown rapidly, employing over 100 energy professionals located in Ireland, the UK, Europe and Japan. The trading team operates 24/7, providing essential trading services to renewable assets including wind farms, solar farms and batteries in 14 separate energy markets.

Underpinning sector – financial services

With years of experience in both the renewable energy and finance sectors, the founders of **Fincovi** had seen first-hand how cumbersome financial management in renewables can be. Roscommon-based Fincovi recognised that as asset bases grow and generate reams of data, data management would need to get smarter. Having initially received funding through the NDRC Portershed Accelerator programme, they were then supported by the Western Development Commission and private investors. This funding and support were critical in the early stages and assisted in the ultimate development of their technology platform, which gathers and manages data on wind and solar funds, generates financial and compliance reports, and mines data for insights. In 2021, Fincovi was acquired by the US-headquartered wind energy tech business, **SkySpecs** (**link**), who saw Fincovi's platform as an opportunity to integrate operating data with financial data and provide their clients with a complete picture for renewable asset management.

> " Our idea wasn't a slam-dunk. It would pivot left and right the whole way. NDRC was hugely valuable in giving us the confidence to push on with the idea and the headspace to frame the solution to make it pass the 'mom test' (why wouldn't everyone want a piece?)"
>
> **John Harney**, Co-Founder of Fincovi

Built environment

The global opportunity

Buildings and construction are responsible for 17% of global GHG emissions. Operational emissions account for nearly two-thirds of this, while the remainder comes from either embodied carbon emissions or the 'upfront' carbon associated with materials and construction processes.[15] To eliminate the carbon footprint of this sector, both buildings and materials must become more efficient, smarter and cheaper. Small-scale efficiencies such as improvements in heating, lighting or appliances will also play a role. Globally, the sector is on the cusp of a technology revolution that will bring the sector into the 21st century. Traditionally, the sector has been slow to adopt new practices and technologies, but challenges such as net zero carbon targets, supply chain issues and escalating costs are disrupting the status quo.

In Ireland

Standing on the shoulders of larger Irish companies in the materials and construction space, Irish innovators are emerging with climate solutions across the materials, construction and building ownership stages.
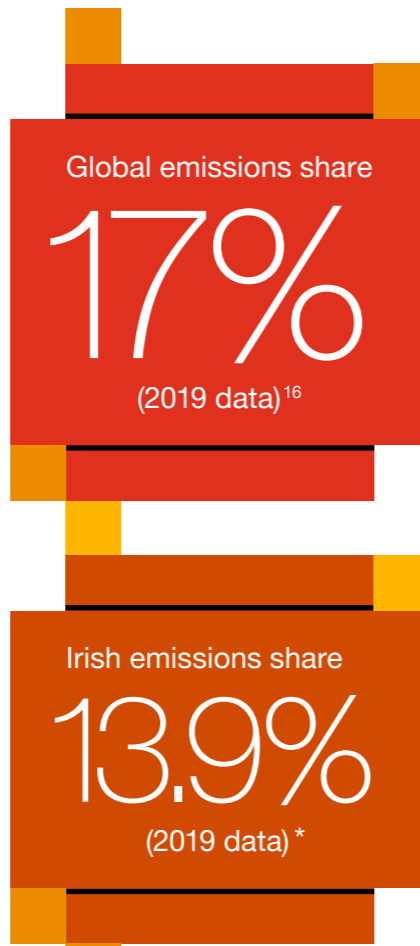
Global emissions share

17%

(2019 data)[16]

Irish emissions share

13.9%

(2019 data) *

* Source: EPA, **Ireland's Provisional Greenhouse Gas Emissions 1990-2019**, viewed on 12/12/2022 (**link**) Includes GHG emissions from commercial services, public services, and the residential built sector.

"

There's no greener energy than the energy you don't consume."

Tom Ascough, Managing Director at Symphony Energy

Smart building management

Opportunities for innovation include the smart management of building energy and resource consumption using sensors, smart devices, artificial intelligence, analysis of the ensuing data and app control for consumers.

Wicklow-based technology company, **Symphony Energy** (**link**) was born from the founders' experience in the energy services industry. Over ten years, through self-financing and bootstrapping, Symphony Energy has developed solutions to optimise efficiencies within the heating, ventilation and cooling (HVAC) components of a building's energy system. Engineer and Managing Director, Tom Ascough, explains how they do this: "In order to get the three HVAC components to work in symphony, we set up the HVAC operations to match the environmental signature (a kind of blueprint) of the building and use technology, including algorithms, to automatically change the settings based on the demands of the building". Their patented Symphony Cycle algorithm harmonises the cooling and heating needs of a building by recycling waste heat to where it's needed in a building. While their WellTech sensors can detect and measure conditions such as movement within a meeting room and update ventilation needs based on this measurement. Their vision is to enable a cost-efficient transition to net zero.

KelTech IoE (**link**) is also leveraging smart technology to drive decarbonisation. Their smart infrastructure solution harnesses the use of a Dual Distributed Network (DDN). This is a hybrid cable that transports energy and data in a single integrated network, enabling public infrastructure (such as street lights) to be used for secondary or multiple uses (such as monitoring air pollution). Their solution integrates into buildings capturing, communicating and analysing data in order to drive decarbonisation. KelTech IoE was selected to take part in Silicon Valley's Telecom Council Innovation Showcase Class of 2022, giving them an opportunity to present their solution to top investors.[17]

Targeting the commercial built environment, **SMART FLOW** (**link**) has developed an automated sensor technology that enables end-users to monitor their water consumption in real-time. Traditionally, users had to manually check their water meters or wait to get the information from their utility company. However, SMART FLOW's technology puts the power back into the hands of the end user and cites approximately 30% savings on water usage for most clients. In impact terms, the SMART FLOW team estimates that their solution saved 1.5bn litres of water in 2022 alone, which equates to over £3.75mn in annual water savings. According to founder, Dave Hogan, having experience in the trenches as mechanical plumbers enabled the company to stay ahead in the marketplace and attract large real estate and hospitality companies in the UK and Ireland.

Construction methods

Opportunities for innovation include efficient construction methods, with an emphasis on ease to construct and reduced waste on-site (in particular, modular construction, 3D printing and imagery/computing).
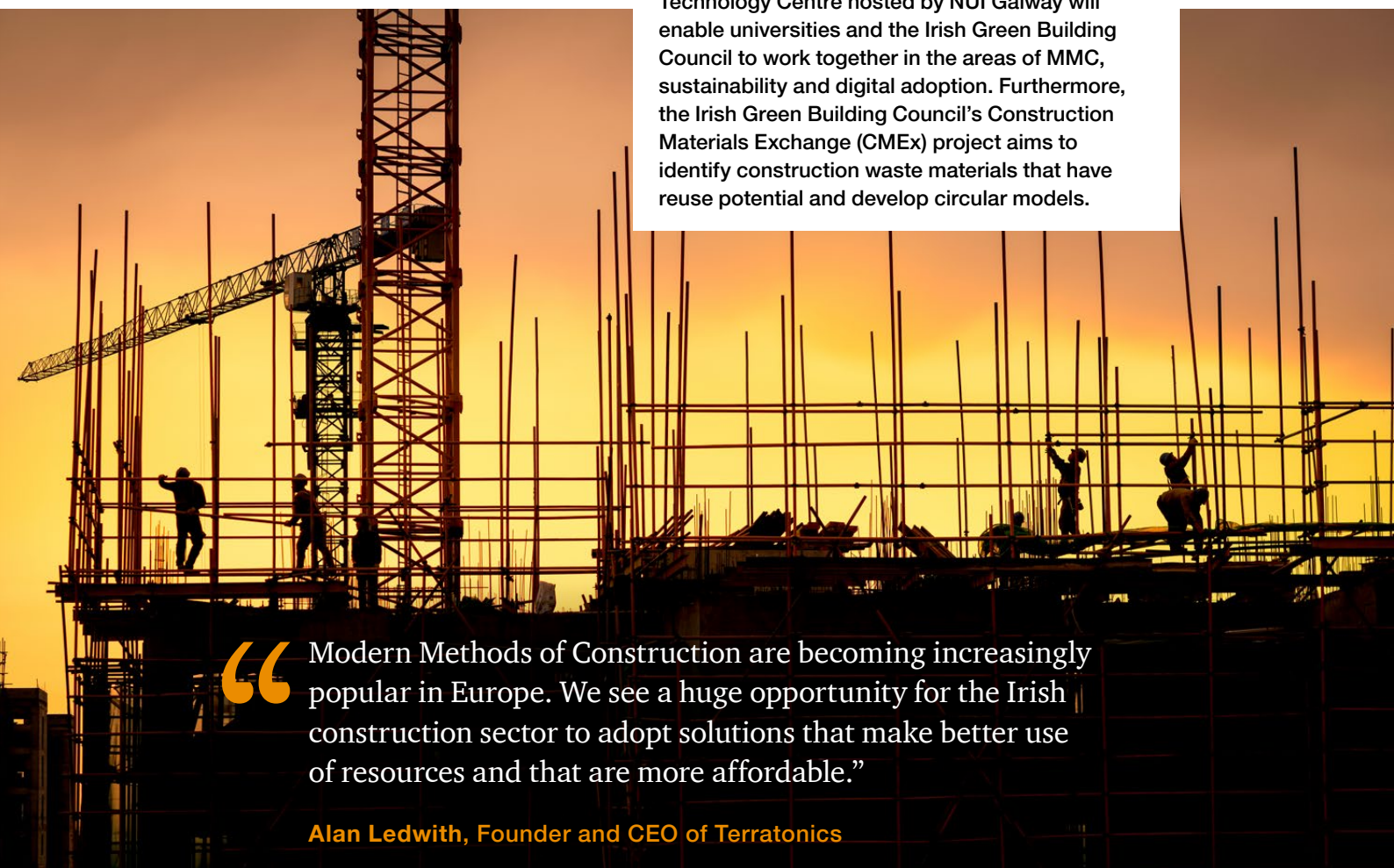
In 2018, the founders of Navan-based company, **Terratonics** (**link**) recognised an opportunity to support Europe's movement towards Modern Methods of Construction (MMC) by improving material and labour efficiencies in construction. They have since developed a concrete-free foundation system for offsite MMC manufacturers, replacing the need for high-emitting cement foundations. The main component of the Terratonics solution is a Terrapod, which is a structural pedestal beam carrier that transfers the building's associated loads to the engineered ground below. The Terrapod is made from an engineering polymer called Nyrim – a material commonly used in the marine sector. The Terratonics team is delivering projects in Ireland and Europe.

Carbon Capture, Utilisation and Storage (CCUS) technologies also have potential to aid the decarbonisation of the construction industry.

Commercialising these technologies could both accelerate their uptake and the rate of decarbonisation. Founded in 2021, **Concrete4Change** (**link**), is developing carbon sequestration technology that injects the CO_2 emitted by industry into concrete. This has a three-fold benefit of locking down the CO_2 permanently; improving the durability of the concrete itself; and reducing the amount of cement needed. Based out of Clare and Sheffield, the company aims to provide commercial licences for their technology in five years, starting first with the EU to take advantage of the impact of carbon taxes as a driving force for change. Sid Pourfalah, CEO and Founder, and Dalraj Nijjar, CCO, are excited by the engagement and eagerness from the market, having already formed a partnership with a global precast manufacturer.

Ecosystem spotlight

Launched in July 2022, a new Construction Technology Centre hosted by NUI Galway will enable universities and the Irish Green Building Council to work together in the areas of MMC, sustainability and digital adoption. Furthermore, the Irish Green Building Council's Construction Materials Exchange (CMEx) project aims to identify construction waste materials that have reuse potential and develop circular models.

> " Modern Methods of Construction are becoming increasingly popular in Europe. We see a huge opportunity for the Irish construction sector to adopt solutions that make better use of resources and that are more affordable."
>
> **Alan Ledwith, Founder and CEO of Terratonics**

Increasing the efficiency of the built environment

Opportunities for innovation include developments in high-efficiency fittings, fixtures, lighting, and heating and cooling for commercial and residential buildings, including district-level solutions.

Clonakilty-based **RetroKit** (**link**) was founded in 2020 by Xavier Dubuisson (CEO), Shay Kavanagh (CTO), and Susan O'Flaherty (COO), building on decades of experience in sustainable energy engineering. After years working with large, complex home-made models for energy analytics, they recognised the need for a robust system to track housing stock and enable the roll-out of retrofit plans. Part-funded by the Sustainable Energy Authority of Ireland (SEAI), they developed an analytics and machine learning platform that models large housing data (such as energy use and BER data) to enable housing professionals and councils to both explore different retrofit scenarios and create energy master plans. Cork City Council was an early adopter of RetroKit's platform to help identify priority areas for energy upgrades and develop the Council's decarbonisation roadmap.[18] Other local authorities and housing associations have since then embraced RetroKit's solutions to plan and deliver their home energy upgrades. With the launch of the new National Retrofit Grant scheme, RetroKit has adapted its platform to support one-stop-shops in scaling up their home energy upgrade operations.

Formed in 2017, **BERWOW's** (**link**) cloud-hosted app harnesses the power of public BER certificate data to provide retrofit dashboards and calculators to homeowners. The homeowner simply inputs their BER certificate number into the app and the system pulls the relevant BER data file, checks the current condition of the house (such as the level of insulation) and recommends best practice upgrade measures. Given that the public BER certificate is not unique to Ireland, BERWOW's co-founder, Feargal O'Neill acknowledges the potential to expand their solution to other countries.

Underpinning sector – Climate Change Management and Reporting (CCMR)

The physical risk of climate change is becoming a very real concern for homeowners and businesses alike. Businesses need to uncover and understand their climate risk blind spots in order to build resilience and transition to net zero – not only the physical risk of floods, fires and droughts, but also the transitional and legislative risks.

Founded in the early 1990s out of Trinity College Dublin, location intelligence company **Gamma** (**link**), was already conceiving how to use location data to solve environmental problems. Their team of data scientists, developers and consultants collect and analyse property-level data, creating cloud-based solutions with maps to address government and industry problems. This could be anything from helping insurance providers understand the risk of environmental damage to a property to helping retailers decide on store locations. Gamma is now operating in Ireland and the UK and looking to expand into other global markets from 2023 onwards.

> " I'm an advocate of finding one niche area that is big enough to be global and spend your time in that and keep at it. Also, don't be afraid to hit a larger market first"
>
> **Feargal O'Neill, CEO of Gamma and Co-Founder of BERWOW**

Food, agriculture and land use

The bioeconomy and natural solutions

Opportunities for innovation include food production methods that harness renewable resources from the bioeconomy (land and sea) to produce natural food, feed and biomaterial that often replace carbon-intensive animal-based products.

In 2018, Irish start-up, **GlasPort Bio** (**link**) recognised the potential for natural solutions to support the COP26 Global Methane Pledge. They are developing additives for animal feed and manure to prevent direct methane emissions from ruminant livestock and stored slurry. The technology works by temporarily inhibiting the microbes in the animal's rumen or slurry which produce methane; preventing the production and release of methane into the atmosphere. In doing so, this improves the animal performance and value of slurry as a fertiliser and source of renewable energy. The company has won a number of awards including The Irish Times Innovation Award 2022 and the InterTradeIreland Seedcorn Sustainability Award.[21] GlasPort Bio aims to launch their GasAbate slurry additive onto the market in 2023.[22]

Insect proteins are also gaining global traction as an alternative, low-emission feed source for both animal and human consumption. Navan-based **Hexafly** (**link**) was founded in 2016 by college friends Alvan Hunt and John Lynam. Anticipating a future challenge in the sustainability and availability of protein, they saw an opportunity to farm insects to produce sustainable protein alternatives to traditional animal feed and fertiliser products. Alvan, who is CEO of the company, explains the process that now takes place in their 15,000 square foot plant in Meath. "The black soldier flies are bred within vertical stacked cages and the resulting hatched larvae are fed raw material waste from the distilling and food industry, essentially upcycling the waste into sustainable products." According to Hexafly, insect farming practices produce 90% fewer CO_2 emissions when compared with other farming methods. Furthermore, Hexafly's products are leading to a reduction in Ireland's reliance on feed and fertiliser imports, which are the foundations of our agriculture and food sector. A contributory factor in Hexafly's early success was the backing and support they received from a global network of investors, including SOSV and HBAN. The company raised the largest HBAN angel investment in agritech at that time.[23]

The global opportunity

Food systems are responsible for 22% of global GHG emissions – the largest contributors being agriculture and land use activities. With an increasing human population, urbanisation and environmental degradation, society is presented with an exacerbated climate change challenge connected to the world's global food industry. Alternative foods and low-GHG proteins is a globally maturing market driven by technological advancements, investor confidence and consumer demand. Vertical and urban farming is another rapidly growing market as the global industry moves to streamline supply chains and stabilise food systems. Value chain GHG reduction is also receiving more focus with technology aimed at reducing emissions in food supply chains (including the reduction of food loss and waste) and the creation of more sustainable packaging solutions that extend shelf life.[19]

In Ireland

Food, agriculture and land use (FALU) is one of the most up-and-coming Irish Climate Tech sectors. It is driven by the urgency to decarbonise Ireland's economy, which is heavily dependent on food and agriculture. This sector is also an integral part of Irish culture and society, and so, change must be managed through a just transition.
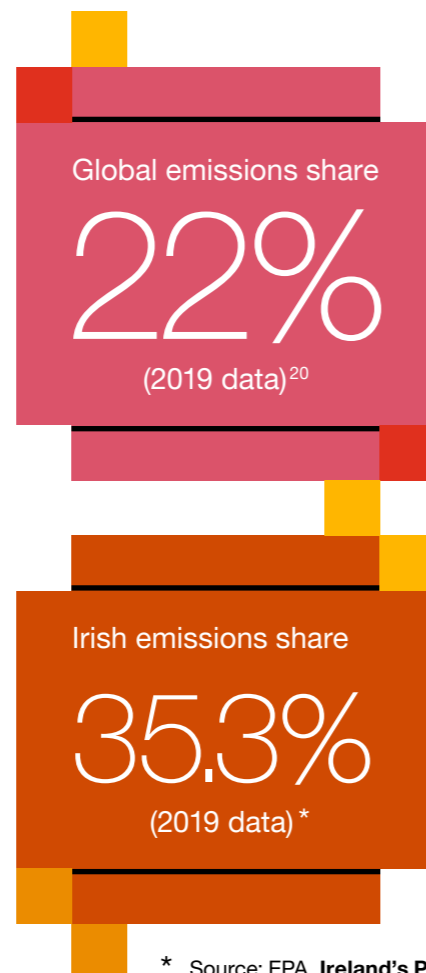
Global emissions share

22%

(2019 data)[20]

Irish emissions share

35.3%

(2019 data)*

* Source: EPA, **Ireland's Provisional Greenhouse Gas Emissions 1990-2019**, viewed on 12/12/2022 (**link**)

Ecosystem spotlight

Teagasc – Ireland's Agriculture and Food Development Authority – has launched Ireland's Climate Action strategy for Agriculture, to meet the sector's target for a 25% reduction in GHG emissions by 2030. Research and development of climate technologies is integral to the road map, with planned phases to develop 'almost-ready' technologies as well as 'early-stage' technologies, such as feed additives at pasture (**link**)

Low-GHG farming

Opportunities for innovation include low-GHG farming practices that improve efficiencies or reduce carbon emissions, such as precision farming, vertical farming and aeroponics.

According to **MagrowTec** (**link**) "70% of pesticides do not reach the desired crop" using traditional application. As well as being costly to farmers, the chemical run-off and drift from the target crop can affect nearby environments and ecosystems. Back in 2013, Gary Wickham and David Moore, founders of MagrowTec, recognised the commercial potential of using magnets in spraying technology to enable the delivery of a more consistent spray profile, reducing drift and chemical waste and providing better crop coverage. After 5 years and €10m invested in research, testing, and development, the MagrowTec Boom kit was commercially launched in 2018. With more than 300 MagrowTec units installed in 10 countries, the company has raised more than €25m to date and employs over 30 people across four territories. Since launching to the market, MagrowTec has also won several awards, including the Thrive Bayer Sustainability 2021 in the scale-up category and the Fieldays Innovation award 2020, amongst others.

"Partnering with local and international academic institutions, such as the SFI Research Centre at Trinity College Dublin, has been critical to building our company. Collaboration is an important part of this process, seeking the best in their field to help facilitate scientific credibility, sustainable growth, customer satisfaction and competitive standing."

Gary Wickham, CEO and Founder of MagrowTec
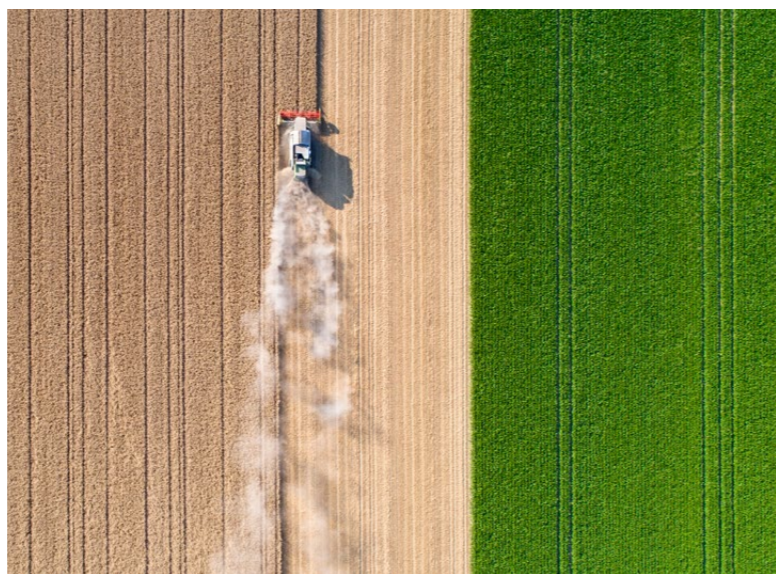
Protection of natural environments

Opportunities for innovation include the management and modification of natural environments, in particular through reforestation, afforestation and avoided deforestation.

The Nature Trust (**link**) was set-up to 'create, restore and rewild natural ecosystems by acquiring land, improving the ecological condition of the land and managing its ecosystems in perpetuity in order to deliver ecosystem services that benefit the climate, nature, communities and wider society'. The not-for-profit company was set up by Coillte and Forestry Partners to bring public and private finance together to deliver impact on nature restoration at scale in Ireland. Managing Director Dr Ciarán Fallon explains that the not-for-profit company has raised €7m for native woodland afforestation in 2022 through its innovative Native Woodland Credit offering and hopes to launch a peatland offering shortly.[24] The Nature Trust offers 100-year land management commitments and all of its lands are maintained on an open-access basis as public amenities.

"There's a bright future for nature-based solutions. However, more standards will be crucial to ensure capital is flowing into high-quality nature projects."

**Ciarán Fallon,** Managing Director of The Nature Trust

Ecosystem spotlight

There is visible corporate engagement in the area of land rehabilitation, with companies like Bord na Móna undertaking bog wetting and the rehabilitation of commercial boglands into nature parks.[25]

Land management

Opportunities for innovation include land management to reduce carbon emissions (such as soil CO$_2$ sequestration).

Dowmann (**link**) is seeking to unlock the value of non-food bio-residues (including roadside clippings) to improve land and soil quality while removing carbon from the atmosphere. Within upcycled, second-hand shipping containers, Dowmann's process, known as 'pyrolysis', converts the bio-residues into a carbon-rich material called biochar. This is then put into soil and locks carbon in while improving the soil's ability to retain water and minerals. The founder of Dowmann, Paul Manning, acknowledges that the process is similar to what neolithic farmers would have done – the only difference is that Dowmann uses ovens, which retain all gases and outputs within the system. For every tonne of biochar produced, Dowmann receives carbon removal credits that are independently verified and sold on the carbon credit exchange.[26] The carbon marketplace is key to the company's growth plan, which is to build and operate their own plants and engage those in the marginalised parts of society for operative roles.
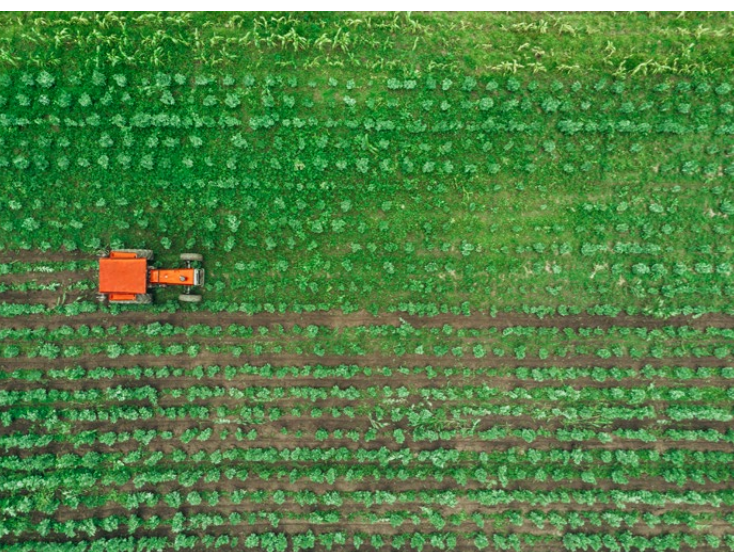
> ❝ The globalisation of the VC market has enabled us to raise global VC capital, including German venture capital firm APX, without ever needing an in-person meeting.”
>
> **Mark Kirwan, CEO of Positive Carbon**

Value chain management

Opportunities for innovation include any activity associated with reduced GHG emissions in food supply chains from production to consumption (such as eliminating spoilage).

In 2013, **FoodCloud** (**link**) founders Iseult Ward and Aoibheann O'Brien, embarked on their journey to tackle the twin issues of food waste and food insecurity. Through a digital platform, FoodCloud connects retailers and food businesses with surplus food with community organisations who could use it. The initiative was initially supported by Trinity's Launchbox Programme as they set-up and developed their digital platform, facilitating food donations and preventing waste. Commenting on their journey, FoodCloud CEO Iseult Ward noted: "We didn't come up with food redistribution. It's a well-established concept, it just needed technology and future-proofing to make it scalable and sustainable." FoodCloud redistributed 16,380 tonnes of surplus food (39 million meals) across four markets in 2021: Ireland, UK, the Czech Republic and Slovakia, contributing to the avoidance of approximately 52,416 tonnes of CO$_2$ equivalent. FoodCloud is looking to expand their technological solution into international markets to scale-up food redistribution globally.

Positive Carbon (**link**), is another Dublin-based company seeking to reduce food waste at consumption stages using technology. The founders initially developed a food waste monitoring system for food retailers, but soon pivoted to the food services industry where they identified a huge opportunity to reduce food waste in commercial kitchens. In co-founder Mark Kirwan's words, "After speaking with kitchen managers and chefs, we realised that the large amounts of food waste comes down to the lack of visibility over the numbers". Positive Carbon's vision technology tracks waste as it goes into bins, enabling kitchens to set baselines for food waste and ultimately reduce their over-purchasing behaviours.

Senoptica Technologies (**link**), is a spin-out company from Trinity College Dublin. Established in 2018, the company seeks to help global retailers reduce food waste throughout their value chain. With only circa 0.03% of Modified Atmosphere (MAP) food packs quality-tested before they leave the factory, Senoptica estimates that "approximately 3-8% of all MAP food packages have "failed" before they even reach the retailer's shelf. Globally, this translates to approximately 5.3bn packs annually, which is the equivalent of 34mn tonnes of CO$_2$ emissions." Senoptica's sensor technology will allow 100% of food packs to be tested at any point in the supply chain and address what CEO, Brendan Rice calls "a seemingly small problem that combined is a massive global problem."

> ❝ 40% of all food produced globally is wasted, at a time when over 2 billion people face moderate or severe food insecurity. 8–10% of global GHGs are related to food waste, that is four times the emissions from global aviation.”
>
> **Iseult Ward, CEO and Co-Founder of FoodCloud**

Ecosystem spotlight

The Government's National Food Waste Prevention Roadmap 2023-2025 sets out actions for the next 3 years to get Ireland on course to reduce food waste by 50% by 2030. Initial measures focus on areas such as, food waste measurement and reporting, food redistribution, research and innovation and food waste segregation (**link**)

Underpinning sector – CCMR, data for earth and marine protection

Earth and marine data enables authorities and industry players to make informed decisions on biodiversity and wildlife protection. Advances in data infrastructure and sensor technologies are accelerating innovation in earth and marine data collection and reporting.

Mobility and transport

The global opportunity

Transport is one of the fastest-growing sources of emissions globally, accounting for 15% of global emissions (having increased by 71% since 1990). The transition to electric vehicles (EV) has been a favoured tool for abating emissions. In addition, developments in green hydrogen in terms of synthetic fuels for transport are expected to be a key driver of the future hydrogen economy. Electrifying transport systems remains a vital part of the net zero transition. EVs are maturing and have reached the point where they now account for over ten million vehicles globally and 4.6% of global annual car sales.[27] However, continued growth in passenger and freight activity could outweigh all mitigation efforts unless transport emissions can be decoupled from GDP growth.[28] Wider interventions will also be critical, including a focus on increasing the attractiveness of different mobility options (modal shift, shared transport and avoided journeys), improved vehicle performance, alternative fuels, high density infrastructure and the built environment.

In Ireland

One of the lesser developed sectors from an innovation perspective, Ireland is now beginning to see an emergence of Climate Tech for mobility to decarbonise transportation systems.
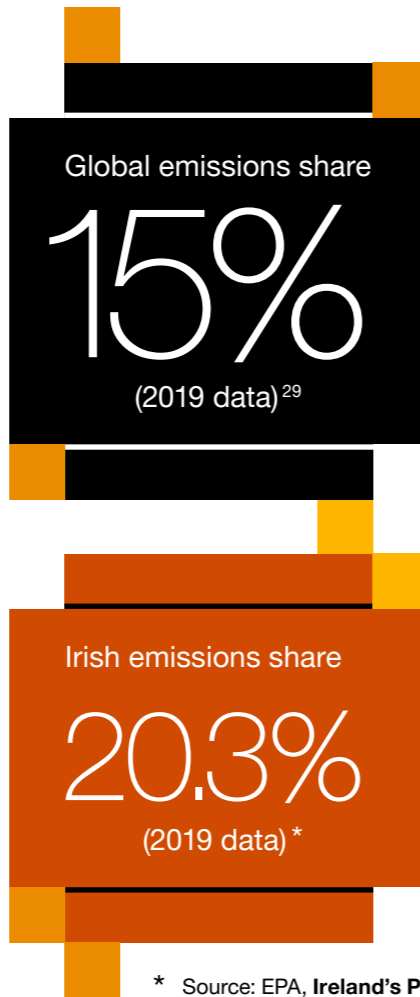
Global emissions share

15%

(2019 data)[29]

Irish emissions share

20.3%

(2019 data) *

* Source: EPA, **Ireland's Provisional Greenhouse Gas Emissions 1990-2019**, viewed on 12/12/2022 (**link**)

> " With an ever-improving road-charging network, (we're) seeing more of those traditional objections to EV purchase falling away."
>
> **David Watson**, Co-Founder of Ohme

Efficient transport systems

Opportunities for innovation include vehicle sensors, journey optimisation and planning, predictive maintenance, systems to manage traffic and other urban planning improvements.

Longford-founded company, **Cityswift**'s (**link**), mission is to "give the public and private sectors the tools to optimise and deliver dynamic networks that are ultra-efficient, reliable, and widely used by people everywhere". Founded in 2016, Cityswift now employs roughly 75 people across the UK and Ireland. Their platform intakes large, unstructured datasets from buses as well as open-source data (such as weather and traffic events) and models these inputs to provide key insights to bus operators and transport authorities. This information can be used to optimise routes, scheduling information and more. Clients include organisations like Transport for London, where the platform is helping to improve its vast commuter network with big data and machine learning. The company recently raised €5m Series A funding, led by Act Venture Capital, which will help them greatly with their global expansion.[30]

Electrification of road transport

Opportunities for innovation include the development of electric vehicles and micro-mobility vehicles, and the infrastructure used to propagate these technologies including shared car-ownership models and charging points.

Ohme (**link**) was founded in 2017 by David Watson and Derry Guy. Operational since 2018, the Cork- and London-based company is providing smart chargers to fleet operators and businesses across the UK and Ireland. Their smart charger gives the control to EV owners to choose whether to charge their car immediately, to charge it when the grid is at its highest level of renewable energy (and therefore lowest CO_2) or when their electricity rate is reduced. The company has grown alongside the demand for EVs, driven by both rising fuel prices and government regulation. For example, new building regulations in Ireland[31] and the UK means that the majority of new builds will be required to have charging points installed or, at a minimum, recharging infrastructure. Ohme is also seeing more interest from employees in the EV company car market, incentivised by the low benefit-in-kind rates.

Another company with a vision to empower fleet electrification is Dublin-based start-up, **EVE** (**link**). EVE's analytics platform integrates vehicle data with en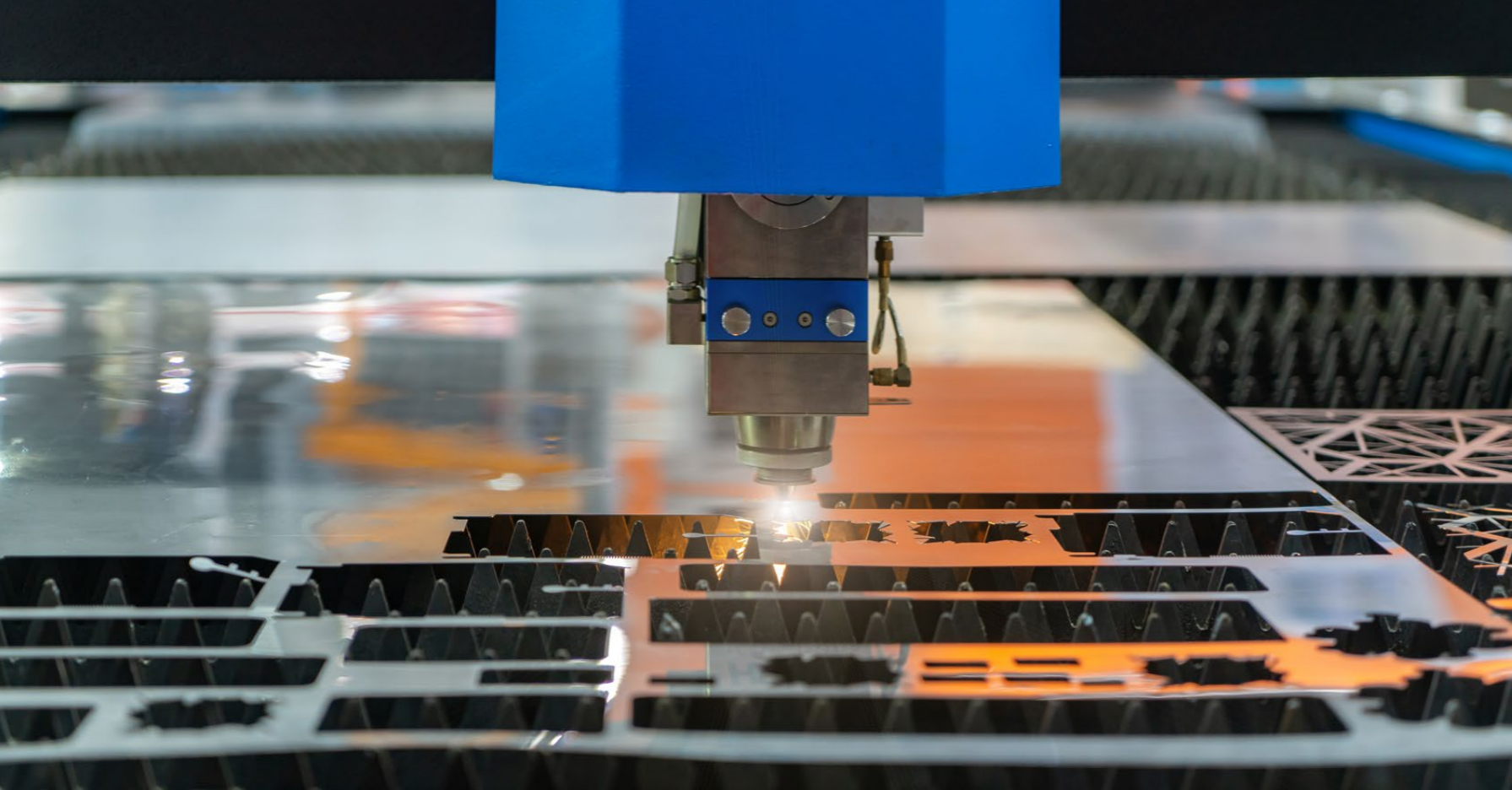ergy grid data, giving visibility into an organisation's charging behaviour, CO_2 emissions and cost, and ultimately enabling organisations to improve their fleet's charging and operational efficiency. Although the start-up has faced challenges around data coverage and data sharing, Sarah-Marie Rust, CEO and Founder, is excited by new EV charging regulation as a key driver of the company's growth. The team is currently working on developing white-labelling capabilities with a "vision to work with EV manufacturers to integrate our software into their service portfolios and car dashboards".

Ecosystem spotlight

R&D in the area of **battery technology** is beginning to emerge in Ireland, with universities such as Limerick's Bernal Institute conducting research. Furthermore, government initiatives are starting to address the transition of heavy-duty vehicles to zero emissions. These include the development of Hydrogen Ireland (**link**), Hydrogen Mobility Ireland (**link**) and the Galway-based Seafuel green hydrogen demonstration project (**link**).

Industry, manufacturing and resource management

Energy and resource efficient processes

Rising energy and resource cost pressures are seeing manufacturers seek more efficient processes. Opportunities for innovation include activities and actions to reduce, reuse or manage waste in manufacturing.

Following years of research into the science of water dynamics, Dr Sean Mulligan established **VorTech Water Solutions** (**link**) in 2019 as a spin-out from the University of Galway. The company's vision is to reduce the energy use and associated installation and maintenance costs of wastewater treatment within municipal settings and across a range of industries, including food production and aquaculture. The aeration process of traditional wastewater treatment is known to be energy intensive. Unlike previous approaches VorTech's system wields the power of vortex flows to bring water to air to achieve direct contact with oxygen. The aerated water then jets back down into the tank, to mix biomass and pollutants and achieve its biodegradation in one step. This process enables energy savings of up to 50% and significantly reduces installation and maintenance costs.

ActionZero (**link**) was founded in 2021 following a strategic merger between consultancy firm Energy Services and the technology firm Straightline Energy Solutions. The company's flagship product, the EscoPod, decarbonises heat using a patented, high temperature heat pump technology. Utilising a heat recovery module and a dynamic distribution system, their technology delivers efficient heating and chilling to industrial processes (such as food processing and

pharma) and the space heating of buildings. The EscoPod delivers heat at an operating temperature well above conventional heat pumps. Therefore, structures where building fabric upgrades are too disruptive (for example, in healthcare settings) or prohibitively expensive, can now consider heat pump technology to drive their decarbonisation programmes. ActionZero has a corporate HQ in Cork City and recently opened a new manufacturing and R&D centre in Tralee with the intention to create up to 80 new engineering and manufacturing jobs across both premises.[34]

Software optimisation also plays a key role in gaining energy and resource efficiencies. Founded in 2008 by entrepreneur Norman Crowley, **CoolPlanet** (**link**) is a global engineering services company that focuses on helping manufacturing companies and commercial buildings optimise their production processes and the efficiency of site equipment. Their decarbonisation management system seeks to give companies greater control over emissions and energy use by analysing and visualising data and alerting users to anomalies and deviations. With early-stage support from Irish-based green investor, BVP, the Wicklow-headquartered company now has offices in four continents and employs over 250 people.

The global opportunity

Globally, industry and manufacturing are responsible for 34% of GHG emissions. These are some of the most difficult challenge areas to abate due to the need to retrofit, upgrade and replace existing equipment, and transform the associated supply chains. The materials and resources needed for industrial processes underpin everyday lives: chemicals from plastics, fertilisers, synthetic fibres, concrete and metals are the basis of many infrastructure materials. Emissions result both from the energy used in the production of the materials, manufacturing and industrial processes, as well as those generated by the industrial process itself. An absolute reduction in emissions from the sector will require the deployment of a broad set of mitigation options – more efficient use of resources, more efficient processes and improved energy efficiency. In addition to the focus on circular business models, governmental and corporate net zero targets are driving momentum on the effective use of energy and resources. These targets are also driving focus on the development of low GHG metals, with some in the private sector setting 2030 and 2050 net zero steel procurement commitments.[32]

In Ireland

Recognising regulatory trends and limitations within the supply chain to access virgin raw materials, the industrial sector is embracing and embedding circular practices in their operations to ensure efficient use of all resources – energy, water and raw materials.

Global emissions share
34%
(2019 data)[33]

Irish emissions share
14.8%
(2019 data) *

* Source: EPA, **Ireland's Provisional Greenhouse Gas Emissions 1990-2019**, viewed on 12/12/2022 (**link**) Includes GHG emissions from manufacturing combustion, industrial processes, fluorinated gases and the waste sector (*this figure consolidates GHG emissions from waste from multiple sectors).

> " Water and energy are inextricably linked. Water use makes up roughly 10% of global GHG emissions due to the energy needed for its extraction, storage, distribution, and treatment."

**Dr Sean Mulligan**, Founder of VorTech Water Solutions

Low-GHG material alternatives

Opportunities for innovation include the creation of low-GHG alternatives to traditional inputs (such as chemicals, steel and plastics).

Established in Dublin in 2000, **Ecocem** (**link**), were pioneers in the production of low-carbon cement in Ireland as an alternative to traditional concrete. While their Ground Granulated Blast-furnace Slag (GGBS)[35] products were not new to the world of construction when the company was launched, they played a key role in bringing the lower carbon material into the Irish market and convincing key players of its advantageous properties. The company supplied GGBS for the world's first carbon neutral convention centre (in Dublin), saving 10,500 tons of CO_2 by changing out normal cement for 70% GGBS.[36]

Ecosystem spotlight
Irish researchers are looking to the bioeconomy to break dependencies on fossil fuel plastics. For example, scientists at DCU were recently awarded over €2mn for their Grain-4 Lab project, which aims to transform brewery waste into bioplastics. Their process to date has used the plastic to form pipettes, petri dishes and other plastic lab consumables.[37]
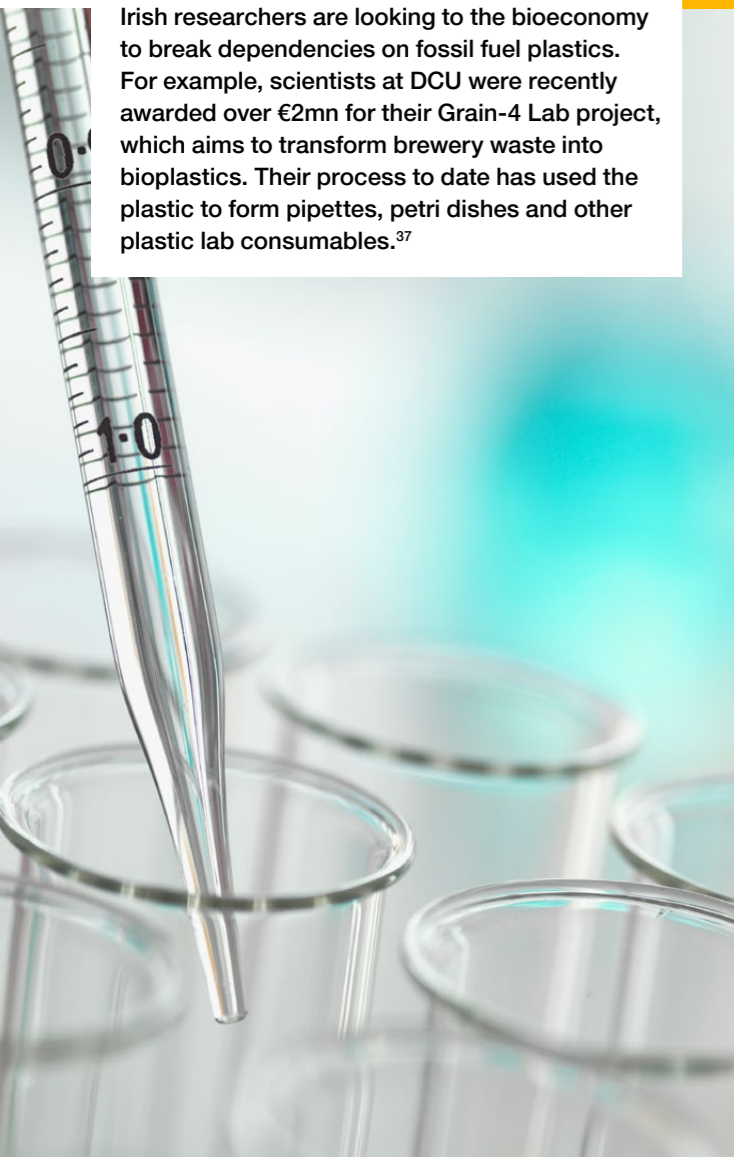
Material recovery

Opportunities for innovation include developments in manufacturing, distribution and end-of-life that reduce material waste, improve recycling rates, or recover and regenerate materials, including transformative circular economy models.

Founder of **The ZeroNet** (**link**), Paul McSweeney, believes that contamination of materials is the "big beast" that must be addressed for a circular economy to work. They've developed an application for homeowners to dispose of unwanted electrical items by having them collected from the doorstep for charity or reuse. This "source separate" model prevents the need to commingle items in recycling banks, which often leads to a reduction in the value of the items and the viability for remanufacturing. By working with county councils and national recyclers, The ZeroNet plan to use their platform to incentivise greater e-waste recovery rates with a particular emphasis on domestic reuse of post-consumer IT equipment. The platform is currently achieving a reuse rate in this category of 35%+, a figure which the company says is best-in-class. Alongside an active project in Brighton, the team have plans to launch the Zeronet platform in two other UK urban areas in 2023 and expand their product collection scope beyond electrical items to include coffee pods and textiles. This project will be a major stepping stone in their mission to service 27 million homes throughout the UK.

> " There are around 53mn tonnes of e-waste dumped globally every year. That's twice as high as the Empire State building."
>
> **Paul McSweeney,** Founder of The ZeroNet

ClimateLaunchpad reinforced the concerns of **Sensi**'s (**link**), Nathan Misischi about the low rates of circularity within the current global economy. He saw an opportunity to use technology to improve recycling rates. Founded in 2019, Sensi's smart reverse vending machines reward individuals when they properly recycle drink containers in retail, corporate and public buildings. Using artificial intelligence, the machines identify the object being recycled and present the recycler with a digital reward token such as a discount code. Sensi's technology allows for simpler, smaller and more robust machines that will play a role in facilitating the Deposit Return Schemes (DRS) in Ireland and across Europe. Nathan believes that the DRS will be key to Ireland achieving the 90% collection rate required by the European single-use plastics directive.

Taking hold of the opportunity to drive the reduction of single-use plastic, founders of the polymer engineering company **Paltech** (**link**), have developed technology to convert these hard-to-recycle plastics into products. Having previously established, and subsequently sold, a plastics engineering company, CEO of Paltech, PJ Feerick, is passionate about overcoming the challenges with recycling low-grade plastics while maintaining their quality. Their system processes the mixed waste plastics and produces 'long-life' products of commercial value, keeping the plastic in circulation. Paltech was awarded EPA green enterprise funding,

enabling the company to complete successful projects in the retail market. It is now looking to develop high-value products, including utility poles and farming containers.

Other Irish companies are developing digital solutions to track and trace products as they move through the value chain. For example, **Verifact** (**link**), has developed a blockchain platform to enable companies to tell verified stories of the origin of their material. In the words of its founder Frank Fleming, "Within a circular economy, you need to be able to tell the story of where the material has come from. Otherwise, the material is no longer worth as much – neither to the company, nor the consumer". Verifact's platform has been used by companies such as a Meath-based recycler to track end-of-life fishing nets as they moved through the recycling process and back into commercial use.[38]

Headquartered in Limerick, **AMCS** (**link**) employs more than 1,200 people across its offices in North America, Europe, and Australia. They provide integrated software and vehicle technology to the environmental, waste, recycling, and resource industries and offer optimisation solutions to the broader transport and logistics market. Their enterprise cloud solutions enable companies to optimise resource distribution processes and streamline their logistics in order to achieve operational efficiencies.

Ecosystem spotlight
State agencies such as the EPA, research organisations such as Irish Manufacturing Research (IMR) and the public-private partnership CirculÉire are all shifting the dial towards more circular practices in industry and manufacturing. For example, a project recently supported by the EPA and being delivered by ÉireComposites aims to develop an innovative process to produce wind turbine blades from recyclable, reinforced plastic.[39]

> " The new Deposit Return Scheme in Ireland will be a significant driving market force not only for us but for circular business models as a whole."
>
> **Nathan Misischi,** Founder of Sensi

Summary

This is a very different Denmark from the one which, when the 1973 oil crisis struck, sourced 90% of its national energy supplies from imported oil, making it one of the OECD countries most dependent on oil for its energy supply.

Since 1996, Denmark has more than halved its CO$_2$ emissions.[42]

The Denmark experience busts the myth that economic growth requires a corresponding increase in energy use and associated emissions.

There is an existing, thriving and dynamic Climate Tech sector in Ireland with a track record of success.

However, the urgency of the climate crisis means that more must be done and at an accelerated pace. This report highlights some of the new and innovative technologies that are being developed to address the climate crisis. The combination of the demand signals from the market, thorough regulation and the availability of capital has allowed an innovation ecosystem to emerge.

Despite this success, more needs to be done. The urgency of the crisis combined with the limited amount of time in which we can make a meaningful impact means that further action is required. One country we could learn from is Denmark. Denmark's 'State of Green' initiative has created a strong identity and brand in Climate Tech innovation – connecting entrepreneurs, corporates, regulators and investors.
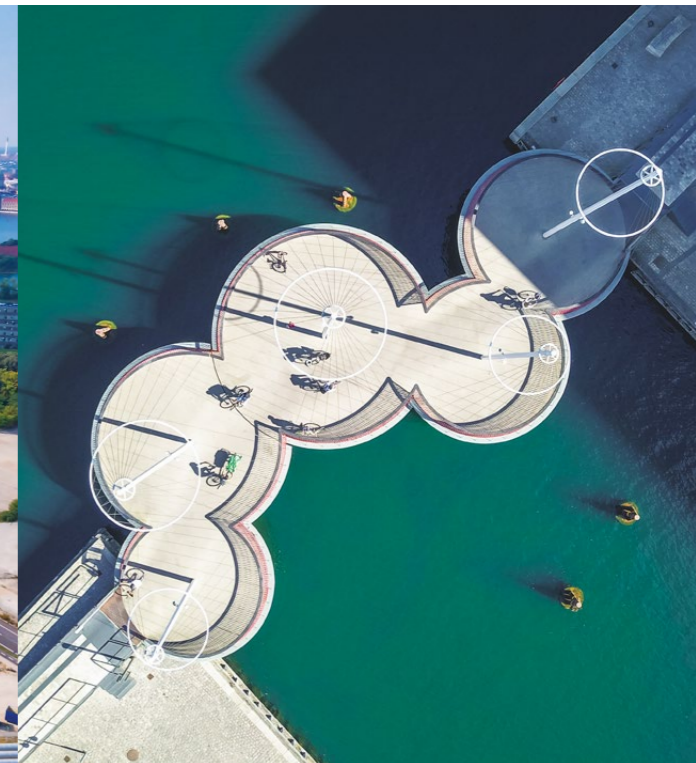
A case study of Denmark's 'State of Green'

The Environmental Performance Index ranks 180 countries on climate change performance, ecosystem vitality and environmental health.[40] In 2022, Denmark once again came out on top of the rankings.[41]

How did Denmark achieve the transition?

One catalyst in the Danish transition is the use of public-private partnerships (PPP) and, in particular, the formation of **State of Green** (**link**) in 2008. State of Green is a not-for-profit PPP, owned by the Danish state and three leading Danish business associations. An influential factor in the transition is the approach taken to policy-making – long-term agreements with a broad consensus across both industry and the political spectrum are agreed on energy and environmental matters. The use of the PPP and the non-partisan approach to policy-making has allowed successive Danish governments to enact regulations and programmes with the support of industry and business, ensuring the successful implementation of, and adherence to, these regulations and programmes.

State of Green acts as a one-stop-shop for over 600 Danish businesses, academic institutions, agencies,

experts and researchers. It connects interested parties with the leading Danish players who are working to drive a global transition to a low-carbon, sustainable, resource-efficient society. Where interested parties approach State of Green with their own challenge in areas such as energy, water, cities or the circular economy, State of Green will connect them with the relevant experts and the tried and tested proposed solutions.

Having contributed to the successful Danish green transition, State of Green recognises that global collaboration is essential to facilitate a green transition. They aim to foster international partnerships while providing a model to be considered globally.

State of Green provides a compelling argument for effective PPPs and industry and political consensus on energy and environmental policy matters.

Calls to action

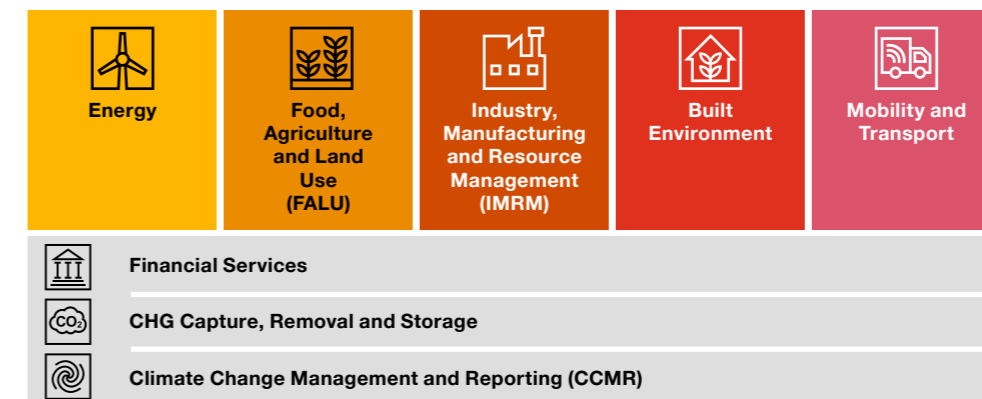### Three critical actions emerged in the formation of this report:

» Initiated by the Government of Ireland but supported by the private sector, Ireland needs an equivalent of **State of Green** (**link**), the initiative of the Danish government. Creating a one-stop-shop for the entire ecosystem – allowing entrepreneurs, regulators and investors to come together – while providing a showcase for customers, will bring the opportunity to the next level.

» To create greater urgency, there needs to be stronger demand signals to the market. This includes both government signals through climate and carbon policies, incentives and green procurement as well as companies developing plans to act on their decarbonisation commitments.

» The sector needs more capital of all types. Capital will flow based on awareness and the fiscal environment. Our next briefing will provide in-depth insights into the Irish investment landscape and how we can attract a greater flow of capital.

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Appendix I:
full Climate Tech definitions

What is Climate Tech?

Climate tech is defined as technologies that are explicitly focused on reducing GHG emissions or addressing the impacts of climate change. Climate Tech applications can be grouped into three broad, sector-agnostic groups:

1. **Those that directly mitigate or remove emissions.**

2. **Those that help us adapt to the impacts of climate change.**

3. **Those that enhance our understanding of the climate.**

The term Climate Tech is purposely broad in order to incorporate the many technologies and innovations being used to address GHG emissions and the wide array of industries where they are being applied. This report considers Climate Tech in relation to opportunities for climate action within five sector vertices and three cross-cutting horizontals. These areas broadly follow the industry classifications set out by the IPCC, which are typically used when discussing emissions reduction.

Energy	Food, Agriculture and Land Use (FALU)	Industry, Manufacturing and Resource Management (IMRM)	Built Environment	Mobility and Transport

	Financial Services
	CHG Capture, Removal and Storage
	Climate Change Management and Reporting (CCMR)

The Climate Tech Landscape

The cross-cutting areas, whilst individually offering opportunity for innovation, can also play a role in driving innovation within each of the above five verticals. Examples of some of the cross-cutting growth areas are highlighted below:

Financial services
Net Zero and ESG agendas are becoming key deciding factors in where financial institutions allocate their capital. Growth areas for disruptive innovators exist across all financial markets' participants, including Lenders; Banking (business and retail); Funds and Investment Banking; Pensions; and Insurance.

GHG capture, removal and storage
Growth areas include Carbon Capture, Uptake and Storage (CCUS); Biomass Update of CO_2 (excluding afforestation and land management); Geo-engineering.

Climate change management and reporting (CCMR)
Accessible and reliable open-source data is essential for climate modelling to get the true picture of climate conditions and enable informed decisions to be made. A well-known example where open data played a critical role was the IPCC reports – providing visibility into where we are today, where we're headed, the causes and the necessary actions. Growth areas for disruptive innovators include Emissions Data, Monitoring, Management and Reporting; Climate Risk and Resilience Management; Climate/Earth Data Generation.

Appendix II:
the methodology

Identifying the entrepreneurs (the research methodology)

The research methodology comprised of four stages of work:

1. **Market scan**
   Using multiple sources, we scanned the Irish market to identify companies that are delivering solutions across the key opportunity areas of decarbonisation, from grid management to precision agriculture.

2. **Assessment**
   We reviewed the identified company solutions and their impact, scalability and maturity to ensure that they aligned to the Climate Tech definitions.

3. **Engagement**
   We connected with a number of companies to get an insight into their company, solution and journey to date. Meetings with company representatives were held during 2022.

4. **Insights development**
   We collated insights from global reports, including PwC publications, desk research on the Climate Tech industry and findings from interviews with Climate Tech innovators.

> It should therefore be noted that the companies included are neither exhaustive nor exclusive, rather intended to give insight into the existing and exciting Climate Tech ecosystem and the opportunities in Ireland. Further it should be noted that the company information, statistics and research included within this report has been derived from publicly available sources and through discussions with the companies themselves. This information has not been independently verified.

Appendix III:
examples of some of the ecosystem stakeholder groups
(this listing is not all inclusive)

Government

Departments and bodies
Bord Bia
Bord Iascaigh Mhara
Central Bank of Ireland
Central Statistics Office
Coillte
Commission for Regulation of Utilities
Department of Agriculture, Food and the Marine
Department of Enterprise, Trade and Employment
Department of Environment, Climate and Communications
Department Of Housing, Local Government and Heritage
Department of Public Expenditure and Reform
Department of Rural and Community Development
Department of Transport
Eirgrid
Enterprise Ireland
Environmental Protection Agency
Housing Agency
Housing Finance Agency
IDA
Intertrade Ireland
Local and Regional Authorities
National Transport Authority
Science Foundation Ireland
Skillnet Ireland
Sustainable Energy Authority of Ireland
Teagasc
Trade and Business Development Body (InterTradeIreland)
Transport Infrastructure Ireland

Initiatives
Connected Autonomous Vehicle Forum
Sustainable Energy Communities
Smart Dublin

Enterprise capital

Irish funders with climate aligned focus
BVP
Climate-KIC
Enterprise Ireland
Halo Business Angel Network Impact Syndicate
Irish Strategic Investment Fund (ISIF)
Just Climate
SOSV
The Yield Lab
VentureWave Capital
Wakeup Capital
Western Development Commission

Universities and research

Research centres with climate-related research
AMBER
BiOrbic
CONFIRM
Construction Technology Centre
Dublin Energy Lab
iCRAG
International Energy Research Centre (IERC)
Irish Manufacturing Research Centre
Irish Transport Research Network
Limerick's Bernal Institute
MaREI Centre
National Biodiversity Data Centre
National Institute for Transport and Logistics
Sustainable Aviation Research Centre
Sustainable Transport & Mobility Research Group
Trinity Centre for Transport Research and Innovation for People (TRIP)
UCD Energy Institute
Irish Green Building Council

Accelerator programmes
Climate-KIC Accelerator
EIC Accelerator
Free Electrons Accelerator Programme
NDRC Portershed
New Frontiers
SOSV (Indie Bio)
Trinity's Launchbox Programme
The Yield Lab

Initiatives
All-Island Food Integrity Initiative
All Ireland Pollinator Plan
Natural Capital Ireland

Corporates

Aer Lingus
An Post
Ardagh Group
Bord na Mona
Bus Eireann
Carbery Group
Combilift
Dublin Bus
ESB
Glen Dimplex
Glenveagh Plc
Hibernia Real Estate Group
Iarnród Éireann
Kilsaran concrete
Munster Joinery
Ryanair
Sisk
Smurfit Kappa
Transdev
UPS
Wellman International

Initiatives
Business for Biodiversity

Appendix IV:
footnotes

1. Source: PwC UK, **Net Zero Economy Index 2022** viewed on 22/09/2022 (**link**)
2. Source: **UN Environment Programme, Emissions Gap Report 2022** viewed on 17/11/2022 (**link**)
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4. Source: PwC Global, **Overcoming inertia in climate tech investing**, viewed on 02/11/2022 (**link**)
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7. Source: MIT, **MIT's Stakeholder Framework for Building & Accelerating Innovation Ecosystems, Budden & Murray, Working Paper, April 2019**, viewed on 30/08/2022 (**link**)
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24. Source: The Woodland Nature's Credit funding instrument enables the Nature Trust to raise capital for the planting of trees at scale through corporate purchasing of the nature credits. See **Bank of Ireland develops first nature-based funding instrument for carbon sequestration, biodiversity and public amenities across Ireland**, Viewed on 02/09/2022 (**link**)
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29. Source: PwC Global, **Overcoming inertia in climate tech investing**, viewed on 02/11/2022 (**link**)
30. Source: Think Business, **Galway's CitySwift raises €5m to roll out globally**, viewed on 18/10/2022 (**link**)
31. Source: Gov.ie, Minister O'Brien signs new regulations for the installation of Electric Vehicle recharging Infrastructure (**link**)
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34. Source: Independent.ie, **Climate tech firm ActionZero to create 50 jobs in Tralee**, viewed on 16/09/2022 (**link**)
35. GGBS is a byproduct of steel production
36. Source: Ecocem, **The Convention Centre Dublin**, viewed on 02/09/2022 (**link**)
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