



THE IRISH ACADEMY OF
ENGINEERING
ENGINEERING & TECHNOLOGY

THOUGHT LEADERSHIP IN A TIME OF GREAT CHANGE

MEGATRENDS

The forces likely to shape
work, employment and
society in Ireland to 2040
and beyond



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THE IRISH ACADEMY OF ENGINEERING

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EXECUTIVE SUMMARY

Some of the global trends likely to affect Ireland¹ over the coming years will present opportunities while others will buffet our shores like Atlantic storms and have the potential to be quite disruptive if not managed effectively – one need only mention climate change in this context.

Numerous global trends of interest or concern could readily be identified. The Academy has chosen to highlight a selection of so-called “megatrends” for further examination. Megatrends are trends that have an effect on a global scale. Those identified by the Academy, while global in nature, were selected on the basis of their likely significance for the future shape of employment in Ireland in the period to 2040 and beyond. The selected list is described and discussed in this paper and includes the following:

- ▲ Decarbonisation and Climate Change
- ▲ New Technology
- ▲ The 4th Industrial Revolution
- ▲ The Circular Economy
- ▲ Remote Working.

Decarbonising our economy

This “trend” is likely to represent one of the biggest economic transformations ever, a transformation that will require innovative solutions, new skills and ultimately the effective mobilisation of the whole of society if the necessary change is to be achieved in a timely manner against an increasingly demanding schedule.

The EU is committing enormous funding to climate change, decarbonisation and digital transformation over the period up to 2030. Significant opportunities are provided by both the EU Green Deal and the EU Recovery Plan. To optimise the benefits of this funding Ireland requires an effective integrated national plan that allows it not only to meet the targets but also to position itself for future sustainable development built on these opportunities.

New Technology

With advances in technology consideration is required of how current industries and society will be impacted and how best to respond to such advances. Equally

thought should be afforded to how change will open up opportunities for new sector participation and growth.

In our view Ireland’s target should be the modernisation and growth of both its FDI and domestic industrial base. Inaction risks inevitable obsolescence and lack of competitiveness. This in turn demands leadership in ensuring the underlying technology infrastructure that makes industry deployment possible is fit for purpose.

There is a need to secure the continued inflow of talent, investment and companies. In an environment where talent can be engaged and lost remotely Ireland, must continue to develop its attractiveness in an holistic manner.

In the light of the disruptive technological changes underway and anticipated Ireland needs to continually revisit its priorities as well as its funding for research, development and innovation.

The Fourth Industrial Revolution (Industry 4.0)

Industry 4.0 will likely provide significant opportunities for employment in the manufacturing sector if a proactive approach is adopted. Failure to act on the other hand could pose significant difficulties for the more than 400,000 people currently employed in manufacturing and related activities.

Many of the job categories in existing manufacturing activities, particularly the operationally intensive roles, are likely to be severely impacted by automation. In parallel there is likely to be a large increase in “new” opportunities including in technical roles.

Upskilling, in which staff gain new skills to help in their current roles, and reskilling, in which staff need the capabilities to take on different or entirely new roles will be key industry policy priorities.

¹ Although the Academy is an all-island body the main focus of the present report is (the Republic of) Ireland

The World Economic Forum (WEF) has stated concerning Industry 4.0 and its impact that *‘gains are not a foregone conclusion. They entail difficult transitions for millions of workers and the need for proactive investment in developing a new surge of agile learners and skilled talent globally...there is a virtuous cycle between new technologies and upskilling’*.

On balance, the Academy shares this view and believes Ireland is well positioned to benefit from this virtuous cycle.

The Circular Economy

This “megatrend” has been building for some time, driven in the main, in the Irish context, by EU regulation and legislation.

The European Parliament defines the circular economy thus:

“The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended.”

The development of the circular economy, like the roll out of digitalisation and the growth of Industry 4.0, is certain to have a major impact on industry and the products it produces. As with Industry 4.0 and New Technology the advent of a serious commitment to realising the circular economy in Ireland will likely present significant investment and employment opportunities.

Regrettably, Ireland has a less than stellar record in this field. Work has now commenced on addressing our hitherto poor performance with the passage of the Circular Economy and Miscellaneous Provisions Act 2022. The Act defines the circular economy for the first time in Irish domestic law as being *“an economic model and policies which give effect to that model”*.

The aims of the circular economy clearly entwine with those of the decarbonisation agenda and this is reflected both in legislation and Government policy. Societal efforts aimed at the development of the circular economy will almost certainly benefit from parallel measures targeting the subject of decarbonisation.

Remote Working

Some aspects of Ireland’s well-established model of competing internationally on the bases of talent and tax and of building industry ecosystems may need to be revisited as part of a concerted response to the (apparently permanent) advent of remote working and derivatives such as hybrid working (part office-based and part home-based). This trend has raised a number of concerns and a corresponding need for sensible solutions.

Remote and hybrid working can change the competitive dynamic between cities and regions and indeed between individual countries and even individual sectors. Talented people now have greater choice in where they live while still pursuing a rewarding career in another town, city or even country. Ideally, both living and working would occur in the same country. It seems inevitable that those regions and countries that offer a better overall quality of life will likely be big winners in the competition for discerning talent.

Making Ireland an attractive place for the internationally mobile has now risen in importance and must be regarded as a priority concern. A holistic approach to improving quality of life in our towns and cities can help provide Ireland with an important differentiator while consideration of related if more practical issues such as personal taxation and access to affordable housing will need close attention and adjustment as required.

Based on our assessment of the various “Megatrends” reviewed herein the Academy’s Recommendations are, in summary:

1. **raise awareness** of the disruptive nature of the opportunities and challenges ahead;
2. create a culture of **innovation** including the creation of an Innovation Council;
3. make Ireland a location of choice, i.e. attracting and retaining **talent**; and
4. invest in **education/skills** to create a labour force that is highly educated, agile, flexible and committed to lifelong learning.

1. CONTEXT

1.1 Introduction

Voltaire said the present is pregnant with the future and this is surely true of the intersecting forces, plans and events or “trends” that will shape Ireland’s society and economy over the medium term (2040 plus). The likely effects of some of these trends are already evident and others still have to reveal themselves more fully. In addition to the trends factors such as our current base of employment, existing national and sectoral plans as well as natural aspirations for a better society will all likely have a bearing on the shape of the future Ireland.

While an island Ireland is clearly not immune from the effects of global trends that can be expected to buffet it in the coming years. These are apart from the other, largely unforeseen, events that arise from time to time and threaten our stability - one need only mention in this context the recent experiences of Brexit, the Covid-19 pandemic and the outbreak of war in Ukraine and their associated economic crises. Some of the trends, identified as “megatrends”, are global in scale and impact. Many have the potential to be quite destructive if our response to the challenges they pose is not managed correctly.

Arguably, one could identify numerous global trends of potential interest or concern and different commentators have made different suggestions in this regard.² The “megatrends” identified by the Academy for further examination were selected on the basis of their likely significance for the future shape of employment and society in Ireland in the period to 2040 and beyond. This selection is described and discussed in this paper and includes the following:

- ▲ Decarbonisation and Climate Change
- ▲ New Technology
- ▲ The 4th Industrial Revolution
- ▲ The Circular Economy
- ▲ Remote Working.

1.2 Ireland’s Current Business Model

Ireland’s ability to provide well-paid and satisfying employment to many hundreds of thousands of its citizens as well as support quality public services in health, education and a myriad of other areas relies on our ability to sell our goods and services at a premium to the world.

Our current economic model has been highly successful, as noted in comments by An Taoiseach:

“Ireland has been the fastest growing economy in Europe over the past decade and the economy is forecast to outperform global GDP growth over the next two years. We have more people at work than ever before, low youth unemployment, and female labour market participation is at an all-time high.

*Our business model is founded on a well-established and successful pro-enterprise policy framework, providing a stable and sustainable regulatory and tax environment, with sound investment in the infrastructure and skills required to ensure our competitiveness”.*³

An Taoiseach went on to refer to Ireland’s attractiveness as a place for Foreign Direct Investment (FDI). While this element of our economic model has been hugely successful it must also be noted that it has also drawn comment for other reasons, i.e. a possibly risky level of over-dependence. Thus, a Sunday newspaper recently noted that “Top ten multinationals account for a record 60 per cent of corporate tax take” and that this was “the highest ever concentration among a handful of U.S. multinationals recorded” (as confirmed by the Department of Finance).⁴

² For example: EY Megatrends 2020 and beyond

³ An Taoiseach, Micheál Martin TD, Foreword to *White Paper on Enterprise 2022-2030*

⁴ *Business Post*, 16th April 2023

In 2021 agency-assisted companies generated sales of €384bn, exports of €346bn, had expenditure in the Irish economy of €63bn and Value Added of €146bn. ICT services accounted for 60% of foreign-owned sales in 2021 and Chemicals for 22% and together these sectors accounted for 82% of sales.⁵

These firms are the engine of the economy and the jobs generated will provide the wealth required to build the Ireland of 2040 and beyond. Preserving and further expanding this employment base, while seeking to mitigate over-dependence risks, will provide a secure basis for future prosperity in Ireland.

Full-time employment in all industrial sectors was over 260,000 in 2022 with a further 211,000 employed in services.^{6, 7} A total of over two and a half million people were in employment in Ireland in 2022, i.e. about half the total population.

By 2040 the Government estimates that the State's population will have grown by about one million to some six million people. If the same proportion as at present of those in employment is assumed, then an additional half a million jobs will have been created in the interim.

What will be the nature of these jobs? What qualifications will be required to ensure we take full advantage of the opportunities presented?

There is little doubt that the current profile of sectoral employment (see Fig. 1) will see dramatic change by 2040. Some of the likely drivers of these changes will be megatrends explored in following sections.

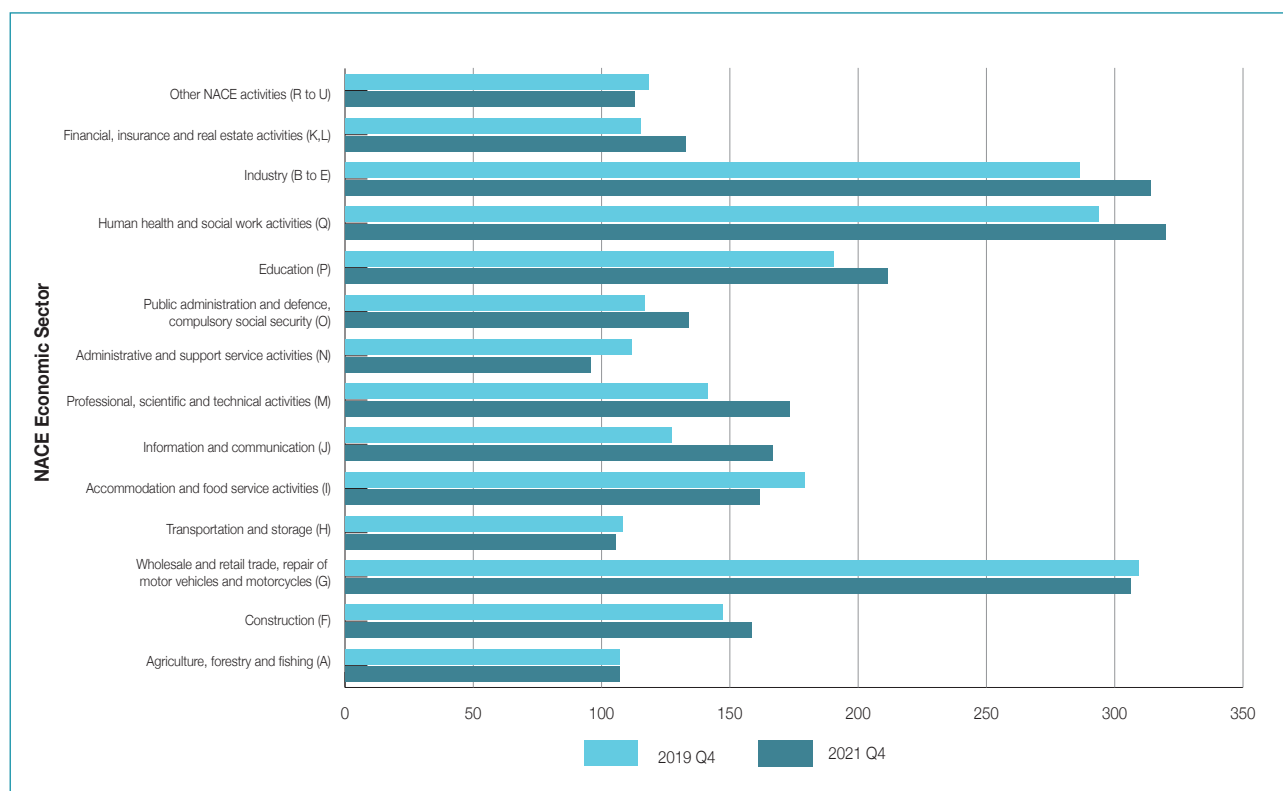


Fig. 1: Employment by Economic Sector by NACE Rev.2 (Source: CSO Q4 2021)

⁵ DETE, *Annual Business Survey of Economic Impact 2021*

⁶ DETE, *Annual Employment Survey 2021*

⁷ IBEC, *Manufacturing Report 2022*

1.3 Are We Over or Under-Educated?

Ensuring adequate candidates of the right sort has serious implications for the future resourcing of our educational system. In its ‘Education at a Glance’ study in 2022 the OECD found that Ireland ranks third in the OECD for the rate of third level education attainment, at 54% as compared with an average of 41%.

While this is a notable achievement it may not be enough to meet the demands of the future, though even those with a close knowledge of the tech sector disagree on how the future will eventually unfold. Thus one ex-CEO of IBM, Ginni Rometty, has argued that workforces are over-qualified; she has stated that 50% of what she calls “good jobs”, i.e. jobs capable of supporting a family of 4, are over-credentialed. Her successor, Arvind Krishna, has, on the other hand, forecast that artificial intelligence (AI) will do away with much white-collar clerical work.

Krishna’s views echo those of Carl Frey and Michael Osborne of Oxford University. They published a noted paper in 2013⁸ in which they claimed that 47% of the tasks American workers perform could be automated away “over the next decade or two”.

It is interesting to note that educational planners in Texas, a hot bed of U.S. economic growth based on new technologies, forecast that over 70% of the state’s jobs will require a credential beyond a high school diploma by 2036.⁹ There is no reason to suppose that Ireland will be any different and this carries with it the certainty that tens of thousands of new third level educational opportunities will have to be created and resourced in an increasingly broad range of subjects in the coming couple of decades.

Many OECD countries report low levels of unemployment at present – 4.9% in December 2022. This is the lowest level for many decades and indeed most rich countries are experiencing historically tight labour markets – and likely to get tighter as societies age.

This will make finding suitable candidates both harder to find and more important to hold on to once hired. It may also be expected to create a lot of legitimate opportunities for AI without impacting negatively on human employment.

Whatever course is followed history shows that while each technological leap results in a proportion of the population experiencing redundancy this is compensated for by the creation of new jobs in ways we often cannot understand or predict – a process that the Austrian economist Joseph Schumpeter called “creative destruction” as far back as 1942. Interestingly, Schumpeter also identified *innovation* as the critical dimension of economic change.

1.4 Irish Government Macro-Planning

The Irish Government has laid out a number of major plans that will have a significant impact on both future work practices and on wider society. These include *Project Ireland 2040* – termed “a long-term overarching strategy that seeks to make Ireland a better country for all of its people”. It is comprised of the National Planning Framework and the National Development Plan 2021-2030. The document sets out key goals for future settlement patterns and land use. It envisages an additional one million population by 2040 of which it is intended a half will opt to live in what the Academy has termed “the Atlantic cities”¹⁰, i.e. the string of towns and cities from Cork to Letterkenny thus reducing the burden on the Greater Dublin area.

Our Rural Future is “a long-term vision for a vibrant and sustainable rural Ireland” and aims to provide “a blueprint for the development of rural Ireland” with a particular focus on the period 2021-2025. One of the key objectives of this policy document includes the completion of the National Broadband Plan including establishing “a comprehensive and integrated national network of 400 Remote Working Hubs”. Others include “Supporting Employment on Rural Areas” and “Enhancing Public Services in Rural Areas”.

The *Climate Action Plan* is a commitment to achieving a net zero carbon energy systems objective for Irish society and in the process, creating a resilient, vibrant and sustainable country.

8 Frey, C.B. and Osborne, M., *The Future of Employment: How susceptible are jobs to computerisation?* Oxford University, 2013

9 *The Economist* March 18th 2023

10 See, for example, the Academy’s 2022 publication “*Atlantic Cities – Towards 2040*”

1.5 Global Megatrends

Global megatrends have the power to radically re-shape the world we live in – and often at a pace that can be surprising, even alarming. In the recent past the Covid pandemic provided an unwelcome reminder of how drastic and sudden the effect of natural forces can be on the often fragile structures of human existence. There is little doubt the Covid crisis accelerated the pace of change of many aspects of the economy and society – both domestically and worldwide.

A positive lesson from that experience is that human society, including the Irish administrative and governmental systems, has more innate resilience than might have been assumed which when combined with the fruits of advanced science and technology allows us to cope with seriously adverse circumstances and ultimately prevail.

A working group within the Irish Academy of Engineering (IAE) considered the wider universe of megatrends and agreed that our response to five major challenges in particular would be likely to significantly impact the future of work, in the broadest sense, on the island. The nature of our response to the challenges posed by these megatrends will play out in a world where globalisation – a trend that proved highly beneficial for Ireland in the past – faces an uncertain post-Covid future and where there are ever changing geopolitical realities. Further uncertainty is created, as already noted, by various threats to Ireland's hitherto highly successful national "business model" founded on a low rate of corporate taxation.

In our view, the future of work and society in Ireland and on the island of Ireland will be greatly influenced in the period to 2040 by five significant trends:

1. **Decarbonisation/Climate Change.** The existential challenge of climate change and the opportunity to create a decarbonised economy and society.
2. **New Technology.** The emergence of multiple new technologies which are *maturing, interconnecting and converging*.
3. **The Fourth Industrial Revolution.** Where developments in *ubiquitous telecomputing* combined with *servitisation*¹¹ and new manufacturing technologies such as *additive manufacturing* (e.g. 3D printing) will impact hugely on industrial systems.
4. **The Circular Economy.** The reality of diminishing natural resources and the need to migrate from a linear to a circular economy.
5. **Remote Working.** The continued growth in remote (and hybrid) working, given a boost during the Covid crisis, and its entrenching in the economy.

In general, the Academy strikes an optimistic note about the future and the potential for continued high quality employment in the Irish economy. We tend towards the view taken by the World Economic Forum (WEF) in 'The Future of Jobs Report 2018':

"As has been the case throughout economic history...augmentation of existing jobs through technology is expected to create wholly new tasks...opening up opportunities for an entirely new range of livelihoods....it is also clear that the 4th Industrial Revolution's wave of technological advancement is set to reduce the number of workers required for certain tasks.... our analysis finds that increased demand for new roles will offset the decreasing demand for others."

But as the WEF report goes on to point out:

"..these gains are not a foregone conclusion. They entail difficult transitions for millions of workers and the need for proactive investment in developing a new surge of agile learners and skilled talent globally...there is a virtuous cycle between new technologies and upskilling."

In this report the Academy examines the five trends in more detail; how they will interact with our current employment base, our aspirations for a better society and our national plans to shape the future of work and employment to 2040 and beyond.

¹¹ Servitisation: where customers pay for a service rather than buying the equipment themselves

Though generally well positioned to benefit from these trends there is, as Minister Paschal Donohoe recently noted, “no room for complacency”.¹² Ireland must continue to nurture and attract a talent base that is characterised by the quality of its education, its agility and its flexibility and a commitment to lifelong learning. Ireland must strive to be an innovation leader and continue to invest in the adoption of new technologies, education, upskilling and reskilling.

Notwithstanding the many current advantages enjoyed by the Irish economy caution is warranted. As the Economic and Social Research Institute (ESRI) has noted:¹³

“Despite the ongoing resilience of the Irish economy, concentration risks in the ICT sector, a tighter monetary policy environment, ongoing uncertainties in the international economy and persistently high price levels pose major challenges to the economy”.

This statement could be read as a timely reminder, even a warning, that vulnerabilities exist. In order to ensure Irish society and the economy are well prepared for any future “uncertainties” and derive the maximum benefit from the changes that will impact work and employment in Ireland in the period to 2040 the Academy is convinced of the need:

- ▲ to promote awareness of the disruptive nature of the opportunities and challenges ahead;
- ▲ to create a culture of innovation (including the setting up of an Innovation Council);
- ▲ to ensure Ireland remains a location of choice, i.e., for attracting and retaining talent;
- ▲ to continue to prioritise investment in education and skills to create a domestic talent base that is highly educated, agile, flexible and committed to lifelong learning.

¹² Speech to IUA webinar, 30th March 2023

¹³ https://www.esri.ie/system/files/publications/QEC2023SPR_0.pdf

2. EXPLORING THE MEGATRENDS



2.1 Decarbonisation and Climate Change

Climate Change has been well described as the existential issue faced by this generation.

At the opening of the World Leaders Summit at COP26 in Glasgow in November 2021, UN Secretary-General António Guterres issued a stark warning:

“Our addiction to fossil fuels is pushing humanity to the brink. We face a stark choice: Either we stop it – or it stops us. It’s time to say: enough”.

The great environmentalist Sir David Attenborough, also at COP26, was optimistic on what we can achieve through focus and collaboration. He said:

“In my lifetime, I’ve witnessed a terrible decline. In yours, you could and should witness a wonderful recovery.”

Overcoming the existential threat that is climate change, requires that we decarbonise the economy. This is likely to represent one of the biggest economic transformations ever - a transformation that will require huge collective effort and investment, innovative solutions and new skills.

2.1.1 European Union Approach to Climate Change

The Green Deal is part of the EU’s response and the Union’s main new growth strategy to transition the Union’s economy to a sustainable economic model. The EU has committed to achieve “climate neutrality” by 2050, i.e. an economy with net zero greenhouse gas emissions. By 2030 a collective, net greenhouse gas emissions reduction target of at least 55% as compared to 1990 is sought.

To achieve these targets the EU will implement a series of initiatives with expenditure planned at more than €1 trillion being committed to climate change, decarbonisation and digital transformation, over the period to 2030. Of that total some €1.2 billion is earmarked for Ireland. In order to optimise the benefits of that funding an effective integrated national plan is required that will allow the targets to be met while also positioning the country for future sustainable growth based on the opportunities provided by both the EU Green Deal and the EU Recovery Plan.

2.1.2 Ireland’s Approach to Climate Change

Under the 2020 Programme for Government (*Our Shared Future*), the Irish Government committed to reducing greenhouse gas emissions by approximately 7% annually, with a cumulative 52% reduction by 2030 and with a target (underpinned in legislation) of net zero carbon by 2050.

Ireland was required to submit a National Recovery and Resilience Plan to the EU, to enable it to draw down the projected €1.2 billion in funding. This was achieved in 2021 and the Plan was subsequently approved by the EU.

The plan was required to address seven flagship areas identified for reforms and investments by the European Commission, follows:

- ▲ Power Up (renewable power generation);
- ▲ Renovate (retrofitting/deep renovation);
- ▲ Recharge and Refuel (electric and hydrogen chargers);
- ▲ Connect (5G coverage);
- ▲ Modernise (digitisation of public administration);
- ▲ Scale Up (cloud services, big data, semi-processors); and
- ▲ Re-skill and Upskill (digital skills, education reform).

The planned investment will present expanded job creation opportunities for both indigenous Irish companies and multinational companies based in Ireland. Such expansion could also contribute to developing a sustainable competitive advantage into the future if the challenges outlined above are addressed in a suitably strategic and integrated manner.

2.1.3 Decarbonisation in Ireland

Addressing climate change will involve decarbonising business models and entire value chains. In Ireland, it is trite to note that the achievement of a more than 50% cumulative reduction in emissions by 2030 and net zero by 2050 presents the Irish Government and society with a major challenge.

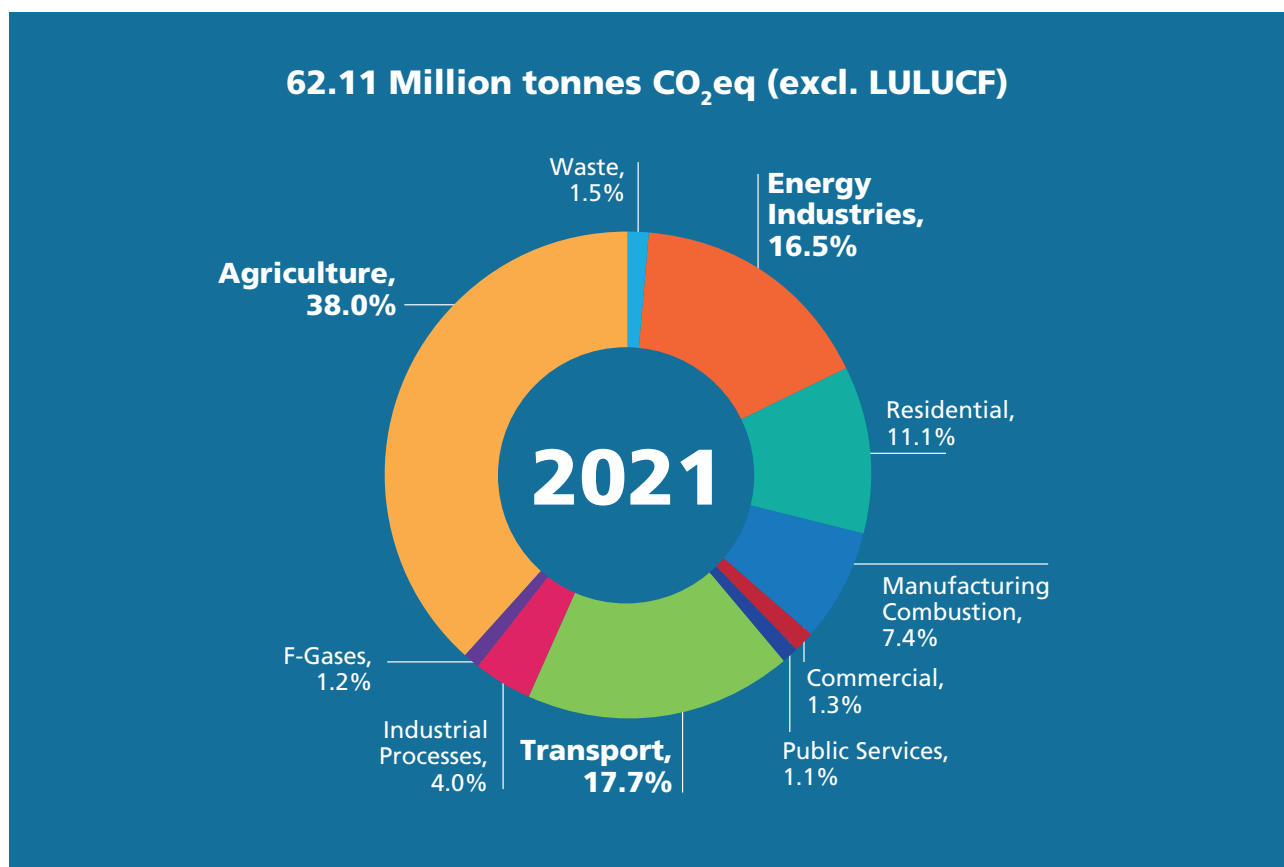


Fig. 2: Greenhouse gas (GHG) emissions by sector in 2021 (Source: EPA)

In 2019, over 71% of emissions came from energy industries, agriculture and transport, with agriculture alone contributing over 37% (Fig.2).

The Irish Government has made commitments in each of these sectors. Thus it is proposed to decarbonise energy production by achieving 70% of electricity generation from renewables by 2030. Agricultural emissions will be reduced by more than 16.5 MtCO₂ equivalent. In the area of transport, it is proposed to have more than 936,000 electric vehicles (EVs) on Irish roads by 2030 and to have

achieved a reduction in emissions of 28% as compared with 2020. (See Fig. 3).

The pursuit and implementation of these goals provides considerable opportunities for companies to participate in the energy transition. In the process they will develop products, services and skills that will support their own development and the overall economy while enabling a broad range of jobs to be created.

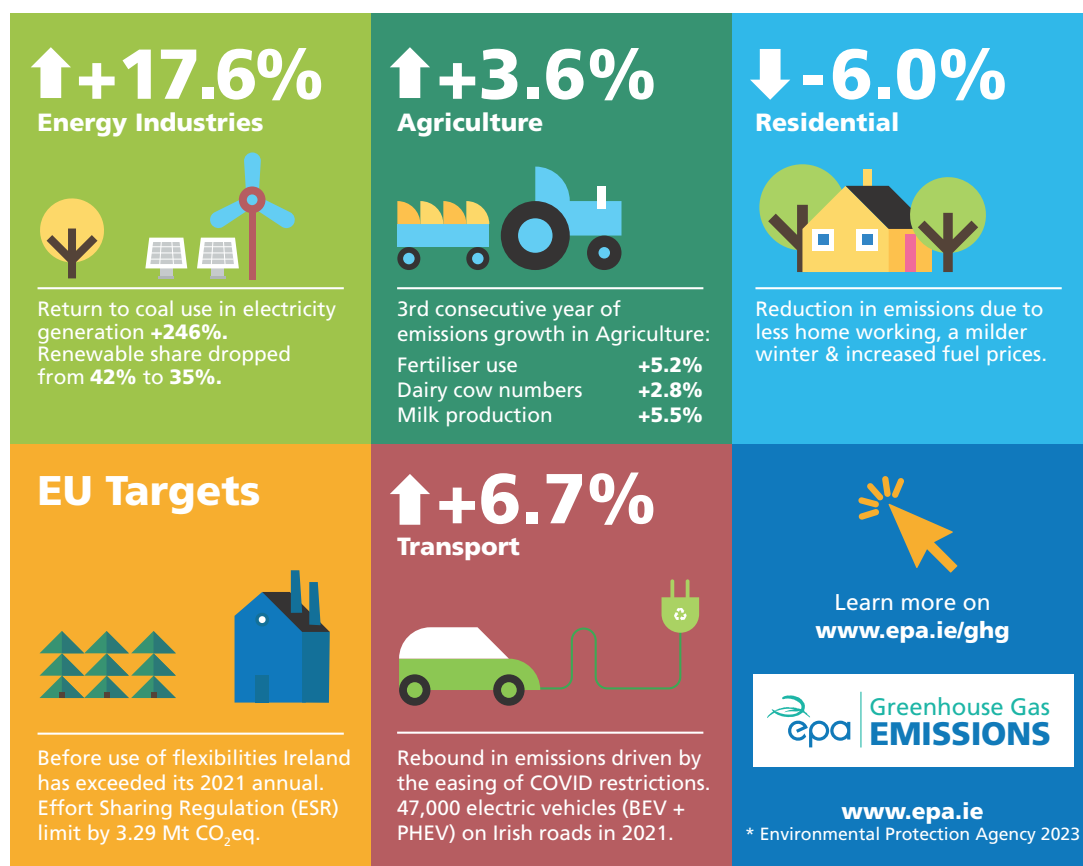


Fig. 3: Projected Reductions in Ireland's GHG Emissions to 2030 (Source: EPA)

While Ireland is one of the world leaders in the development of renewable electricity (43% in 2020), the challenge for energy policy is to continue to guarantee a resilient and secure electricity supply while expanding renewable energy generation still further (to 70%) and to do this in a cost-effective manner.

There is a very difficult balance required to achieve this, particularly in view of the absolute scale of the decarbonisation challenge. It will also have to be achieved at the very edge of what is technically feasible and within very demanding timelines. The scope, and arguably the need, for new and innovative technologies is considerable.

Already electricity markets and systems are highly dependent on cutting edge applications of ICT, data sciences and other techniques.

2.1.4 The Scale of the Decarbonisation Challenge

Virtually all developed countries are now addressing the climate issue in some manner and, as has been noted, Ireland and the EU are committed to investing significantly in the sector to 2030 and beyond.

Electricity “*will be the backbone of the entire energy system*” by 2050.¹⁴ To accommodate the anticipated demand from sectors such as industrial and domestic heating and transportation unprecedented investment will be required in new generation infrastructure as well as in transmission capacity. An international body, the Energy Transmissions Commission, recently reported that \$1.1 trillion must be spent on the grid every year globally until 2050 in order to reach new zero by that date.¹⁵

Although Ireland is already a leading country in respect of the decarbonisation of its electricity sector the commitment to generate 70% electricity from renewables

¹⁴ Gerard Saige, CTO Hitachi Energy, quoted in *The Economist*, April 8th 2023

¹⁵ <https://www.energy-transitions.org/publications/financing-the-transition-etc/>

by 2030 poses real challenges for the Irish electricity system. Expanding the grid to capture generation from both onshore and offshore wind is another major challenge. The Academy has examined many of these issues in a series of recent papers which may be viewed free of charge at www.iae.ie.

Cost-effective technical solutions are clearly required and these will provide opportunities for Irish companies to develop products, patents and services that can be used not only in the Irish market but also exported – especially if an early mover advantage can be exploited.

The task for Government and the relevant State bodies is to help create a suitable environment for all stakeholders. Researchers, academics, business and commercial State companies in the energy sector and, where possible, local communities, should be encouraged to work together in a ‘test bed’ or ‘living laboratory’ mode to help deliver decarbonisation in Ireland and create valuable export opportunities for products and services in the sector.

Away from the energy sector the challenges posed by securing the decarbonisation of other component parts of the Irish economy are if anything even more formidable. For example, the Brookings Institution identifies steel, cement and chemicals as the top three emitting industries and “*are among the most difficult to decarbonise...*”¹⁶ This reality poses significant issues for Ireland and indeed for all countries, developed and developing alike.

Success on the path to decarbonisation will be dependent on the expenditure of prodigious sums for investment in infrastructure and social programmes over an extended period. The scale of the political, social and economic commitment required to achieve net zero emissions by 2050 will likely be testing of political commitment and social cohesion, not only in Ireland but across the world.

¹⁶ “*The challenge of decarbonising heavy industry*”, The Brookings Institution, June 2021

2.2 New Technology



2.2.1 The AI Revolution

Thomas Friedman, writing in the *New York Times*¹⁷ described ‘a most remarkable and unsettling experience’ when given a demonstration of GPT-4, the latest incarnation of the artificial intelligence (AI) chatbot ChatGPT, which was launched in November 2022.

The demonstration was given by Craig Mundie, the former chief research and strategy officer for Microsoft, owners of the software. Before starting the demo Friedman reported Mundie as saying: “You need to understand this is going to change everything about how we do everything”. Following the demonstration Friedman concluded that Mundie’s apparently extravagant claim was “an understatement”.

ChatGPT and similar innovations such as Bard represent one example of the emergence of multiple new and evolving technologies which are maturing, interconnecting and converging in a way that have the potential to radically change the competitive landscape for all economies.¹⁷

In a recent report on AI, McKinsey stated that “the biggest revenue effects are found in marketing and sales, product and service development, and strategy and corporate finance, and respondents report the highest cost benefits from AI in supply chain management”.¹⁸

The accelerating speed of development and the potential impact of AI may have on employment and society in general is even unnerving some of those, including Elon Musk, who are generally regarded as champions and even prophets of AI. Calls have even been made for a moratorium on further development, unlikely to be agreed, to allow time for protocols on future usage to be agreed.¹⁹

Inevitably change on this scale represents both opportunity and threat to Ireland’s current business model and international competitiveness. Social and behavioural changes enabled by such changes exacerbate the challenge and yet hold the key to a successful potential response.

Goldman Sachs suggest that the equivalent of 300 million full-time jobs could be lost due to this trend – especially “generative AI” such as Chat GPT.²⁰ The Goldman report forecasts that the administrative and legal sectors will see the maximum impact with 46% of admin jobs and

44% of those in the legal sector risking replacement by AI. However in an echo of Joseph Schumpeter’s ‘creative destruction’ concept discussed already the Goldman report notes that 60% of people are currently working in jobs that didn’t exist in 1945.

It would be foolish not to revisit the current Irish economic model of competing on talent and tax and seek to re-cast industry ecosystems in the light of these developments. No doubt such revision is not only underway but ongoing.

As part of this process we should consider how our current industries and society will be impacted by new technology megatrend and plan our response carefully while also considering the opportunities presented for new sector participation and growth.

As Friedman said in his NYT article:

“We are going to need to develop what I call “complex adaptive coalitions” — where business, government, social entrepreneurs, educators, competing superpowers and moral philosophers all come together to define how we get the best and cushion the worst of AI”.

2.2.2 Connectivity

We are moving into an era of ubiquitous telecomputing (including and beyond cloud computing and 5G). We have moved from an “App-centric” environment, where computing was limited by human consumption, to a “data-centric” world where the human gives way to the machine as the driver for deployed intelligence, as is the case with ChatGPT.

¹⁷ March 22nd 2023

¹⁸ McKinsey, “The state of AI in 2022”, December 2022

¹⁹ “Elon Musk and other tech experts call for ‘pause’ on advanced AI systems”, *Financial Times*, March 29th 2023

²⁰ <https://www.bbc.com/news/technology-65102150>

It is critical that we plan and provide effectively for the incentivisation and adoption of this expanded intelligence into our manufacturing and service industries. The target should be the continued modernisation and adaptation of our economic base (FDI and homegrown) to this trend as inaction risks obsolescence and lack of competitiveness.

2.2.3 Technology Convergence

The convergence of technologies is expected to play a greater role in defining the future shape of the Irish economy. Such convergence is all around us already – from our wristwatches that also function as health monitors to our smartphones that can be used as GPS devices, music players or cameras. ICT (Information Communications Technology, hardware and software) and LifeSciences are another “*convergence in progress*”.

The semiconductor industry continues to extend capability boundaries in metrology, process control and efficiency through artificial intelligence, machine learning (ML), the Internet of Things (IoT) and blockchain technologies in product performance, cost and miniaturisation through materials development.

These developments are being translated into new products and new services in fields such as spatial genomics and digital pathology and is of immediate significance in upgrading pharmaceutical and medical device manufacturing, raising productivity and quality. Ireland will need to embrace and exploit such convergence to sustain and develop its key industry segments.

2.2.4 Climate and Technology

Climate change has the potential to impact food and agriculture - two of Ireland’s most significant domestic industries - in a negative way.

Mitigation may be provided by digital transformation, advanced (remote) sensing, predictive soil models and co-cropping systems. These initiatives can support precision agriculture and automated farming – already a fact on many Irish farms - can replace manual labour, leading to higher farm productivity and increased revenue as well as a reduction in environmental footprint by reducing chemical (pesticides, insecticide and fertilizer) and energy use.

Much of Irish agriculture is devoted to animal protein production (dairy and meat). Combined, these sectors are responsible for nearly 40% of Irish carbon emissions. Research has enabled improved digestibility and nutrient utilisation in the cow gastrointestinal tract which can achieve reductions in emissions of 20-30%. More drastic transformation and reduction of carbon intensity will however be required to allow growth in the food industries, such as the fermentative manufacturing of food and feed proteins as well as cultured meat. Coexistence of both the traditional and synthetic production of animal protein are envisioned, complementing farmer income, and creating social licence for the transformation.

The continuing dependence of our economy on hydrocarbons is of concern looking to the future. Harnessing offshore wind energy potential will provide energy for domestic needs, transport and manufacturing – while opening the possibility of exports either as power or in the form of green hydrogen. District heating systems are also a longer term possibility.

Smart development of these possibilities would allow Ireland to become a global test bed for clean technologies and their implementation and to be an innovation leader in Europe. However, none of this can happen without a strong commitment from Government to realising the vision by providing the legal, institutional and economic framework required.

2.2.5 Leveraging our Research Infrastructure

In the last twenty years or so national competitiveness has been facilitated through the technology centre programmes of Enterprise Ireland (EI) and the world class centres of scale developed and managed by Science Foundation Ireland (SFI). These centres aligned well to the priority areas identified in Research and Development/ Innovation (R&DI) strategy documents over the years and have been a powerful asset in the toolbox of both the Industrial Development Authority (IDA) and Enterprise Ireland (EI) in driving economic activity.

In 2000 total Government investment in R&DI was €250m and has grown in the interim to reach about €1bn annually placing Ireland in 5th place in Europe. Additional expenditure by business (c.€3.39bn) and higher education (c.€1.04bn) brings the total spend to over €4.5bn annually.²¹

²¹ Impact 2030: Ireland’s Research and Innovation Strategy, DFHERIS 2022

Ireland has also seen the growth of dynamic and enterprising tech innovation and entrepreneur incubation spaces in major cities including Republic of Work (Cork), Portershed (Galway), Dogpatch (Dublin) as well as the Belfast Enterprise Hub in Northern Ireland, which is supported by the Irish Academy's UK sister organisation, the Royal Academy of Engineering.

However in light of the disruptive technological changes both currently underway and anticipated the Academy believes we need to revisit our research funding priorities. We need to consider how best to utilise the powerful toolbox created by the SFI centres; the major problems and opportunities in our immediate future may best be tackled by multidisciplinary approaches.

What better way is there to leverage SFI's budget than to extract synergies and output from inter-connected and linked centre programmes? Key focus areas for further investment and inter-centre collaboration include Health, Wellbeing and Longevity, Climate Action, the Data Economy and Connectivity. Potentially critical skillsets should not be overlooked in this context. For example, the Social Sciences could be included with STEM in the effective translation of research investments incorporating human centric design in MedTech, AI and other fields. In this way the societal impact of technological advances might well be much better managed.

Ubiquitous computing and distributed intelligence, as well as the IoT and AI, will open up many new actionable insights and this may drive an acceleration of learning and a contraction of product development cycles. This process may lead to reduced times for replacement or obsolescence, in effect shorter product life cycles. In contrast the trend towards servitisation, not to mention the growth in the circular economy, may help to balance or mitigate these forces.

All of these influences have the potential to unsettle or even disrupt the positioning of current industries with unknown consequences and could represent potential economic risks. This fact should be reflected in economic forward planning and modelling and in future policy formulation.



2.3 The Fourth Industrial Revolution - Industry 4.0

The first industrial revolution was enabled in large part by the availability of steam power in the late 18th and early 19th centuries. The second industrial revolution was characterised by scientific discovery and technological innovation in a broad range of fields from industrial production to transport to communications in the later 19th and early 20th centuries. The third in the series is generally viewed as having started in the 1950s with an accelerating move from analogue and mechanical technology to digital electronics.

Certain lessons are clear from these prior experiences – major changes necessitate a relatively long period of adjustment and there are ‘winners and losers’ before increased productivity and associated wealth creation are fully realised and ‘stability’ is restored. A similar pattern may be anticipated in the currently rapidly evolving fourth industrial revolution.

2.3.1 Industry 3.0

The most recent ‘industrial revolution’ occurred from the 1950s to the 1980s as the emergence of software-based systems paved the way for the development of flexible automation and the development of efficient manufacturing and assembly systems.

Ireland did well from the Industry 3.0 wave by positioning itself as a preferred location for manufacturing and mobile investment in ICT and Life Sciences.

The Financial Times noted in April 2021: *“Manufacturing matters....its disproportionate benefits to the economy. In the U.S., for example, although manufacturing represents just 11% of gross domestic product and 8% of direct employment, it drives 20% of the country’s capital investment, 30% of productivity growth, 60% of exports and 70% of business R&D, according to figures from the McKinsey Global Institute”.*

By 2022 Ireland had become a very successful manufacturing hub and had achieved a remarkable level of European significance in several sectors. These include:²²

- ▲ No.2 exporter of medical devices in Europe
- ▲ No.1 exporter of contact lenses in Europe
- ▲ No. 2 exporter of complex pharmaceutical goods and medicines in Europe
- ▲ No. 1 exporter of dairy ingredients, beef, lamb and spirits in Europe
- ▲ No.1 exporter of specialised nutrition products in Europe.

Ireland now provides a strong manufacturing base for some of the world’s leading companies particularly in ICT and Life Sciences.

It was noted in Section 1.1 above that there are currently approximately a quarter of a million people employed directly in manufacturing in Ireland, accounting for about 12% of all employment and contributing some 37% to GDP. Payroll (wages and employment taxes) totalled €12.5bn in 2022.

Including those employed because of manufacturing the total engaged in the sector is over 409,000 people or about 16% of all employment in 2022. In addition Irish manufacturers employ 150,000 people in overseas locations.

The Irish economy continues to generate employment at a remarkable rate; Minister Paschal Donohoe recently stated that total employment had grown by over 400,000 from Q1 2019 to Q1 2023 to reach a total of over 2.6 million.

People are employed across a broad range of occupations, from operatives, technicians and trades to engineering and technology professionals while manufacturing is regionally dispersed, providing employment opportunities throughout the country.

2.3.2 Industry 4.0

Industry 4.0 is a further development of Industry 3.0; it represents disruptive change; it is a consequence of and an enabler of servitisation and through the development of additive manufacturing (AM) opens up the possibility of localised manufacturing and efficient small batch production. AM is made possible by the transition from

²² IBEC, *Manufacturing in Ireland 2022*

analogue to digital processes and is now bringing digital flexibility and efficiency to manufacturing operations.

In the world of Industry 4.0 the lines between manufacturing and services become blurred. The customer will increasingly move from product owner to service user with the user buying access to a service rather than owning a product, in transportation, computing, entertainment, telecommunications and so on, i.e. the essence of the servitisation trend.

In the report 'Ireland's Industry 4.0 Strategy 2020-2025' the Irish Government lays out the ambition *'that by 2025 Ireland will be a competitive, innovation-driven manufacturing hub at the frontier of the fourth industrial revolution and at the forefront of Industry 4.0 development and adoption.'*

The University of Cambridge noted in its January 2018 report 'Study on digitalisation of the manufacturing sector and the policy implications for Ireland' that *'Ireland is particularly well positioned to pursue opportunities arising from the digitalisation of manufacturing. The country has built important industrial capabilities over decades and hosts a disproportionate share of top global firms in a few manufacturing sectors (both process industries and product manufacturing), many of which have established globally strategic sites in Ireland. Ireland is also home to a thriving community of indigenous SMEs'.*

Manufacturing companies in Ireland will have to evolve to meet the needs of the new environment. Opportunities exist to develop new business models and to enhance productivity and competitiveness by focussing on innovation and talent. Success will require significant investment in the enabling technologies of AM, advanced sensors, low cost pervasive computing and connectivity.

2.3.3 Employment

Industry 4.0 is certain to provide significant opportunities to expand manufacturing employment in the Irish economy. Failure to act correctly and decisively could pose risks for the 400,000 plus jobs currently provided in manufacturing and related activities. Further, the nature of manufacturing jobs is likely to change radically as a result of Industry 4.0.

Capitalising on the opportunities presented by Industry 4.0 will require Government to:

- ▲ raise awareness of the likely scale of the disruption;
- ▲ drive innovation and the adoption of new technologies; and
- ▲ develop a reliable supply of appropriate talents and skills.

Ireland has already invested in a number of centres engaged in RD&I in the field of advanced manufacturing. There are two Science Foundation Ireland Centres (Confirm and I-Form) and two EI/IDA Technology Centres (IMR and AMC).

IMR or Irish Manufacturing Research, based in Mullingar, is *"an independent manufacturing and industrial energy efficiency centre focused on delivering solutions for the manufacturing ecosystem throughout Ireland"*. AMC, now Digital Manufacturing Ireland (DMI), based in the IDA's National Technology Park in Limerick, is Ireland's *"national exemplar for world class digital and smart manufacturing"* and is directly aligned to the Government's Industry 4.0 strategy, *"supporting digitalisation and upskilling of Ireland's manufacturing sector"*.

These investments are very welcome. Many of the job categories in existing manufacturing activities, particularly the operationally intensive roles, are likely to be severely impacted by automation, whereas in parallel there is likely to be a large increase in technical roles. Both upskilling, in which staff gain new skills to help in their current positions, and reskilling, in which staff are provided with the new skills to take on entirely new functions, must be key priorities for Government and industrial employers alike.



2.4 The Circular Economy

2.4.1 Introduction

Ireland can proactively choose to be ‘green, circular and digital by design’ or to respond to changes as they emerge in a reactive manner. There are risks associated with both approaches and it is the Academy’s view that proactivity, approached sensibly, is the preferred route.

As a relatively small, highly globalised economy Ireland will inevitably be (mainly) a taker rather than a giver of new ways of working. However by choosing to take a decidedly proactive approach, by scanning the horizon continuously and taking advantage of appropriate new opportunities as they emerge the economy can be continually shaped and guided to maximum advantage. This is a pattern Ireland is already very familiar with and our approach to the advent of the circular economy should follow this model.

All of the megatrends reviewed here are inter-related, as might be expected. All will contribute in measure to the achievement of a sustainable manufacturing base, defined by the U.S. EPA as one that creates “*manufactured goods through economically sound processes that minimise environmental impacts while conserving energy and natural resources*”.

The development of the circular economy, as opposed to the traditional linear model, and in common with the other megatrends, is certain to have a major impact on industry and manufacturing in Ireland.

Major traditional industries are already undergoing huge change. An example is the automotive sector where recent rapid growth in demand for electric vehicles (EVs) is changing the very nature of the personal transport market and indeed the very nature of the automobile for the first time in over a century.

This is disruption writ large in practice. Whereas the internal combustion engine accounts for a significant portion of the value added in conventional vehicles in EVs (and in future, autonomous vehicles) software will be the significant component. Other industrial sectors face similar disruption.

As it happens cars are a good example of expensive to make and acquire goods that are used infrequently – it is commonly accepted that the average car spends just 2% of its lifetime on the road. Overall, on average many commonly used manufactured goods – employing often finite resources of materials and energy – lose from a quarter to over a half of their material value over a 3-year

period. Such practice hardly represents a sustainable approach to development and can be expected to undergo radical change as the circular economy gains a firmer foothold.²³

2.4.2 EU Approach to the Circular Economy

The European Parliament defines the circular economy thus:

“The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended.

In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible thanks to recycling. These can be productively used again and again, thereby creating further value.

This is a departure from the traditional, linear economic model, which is based on a take-make-consume-throw away pattern. This model relies on large quantities of cheap, easily accessible materials and energy”.

²³ <https://www.self.inc/info/lost-value-depreciate-most/>

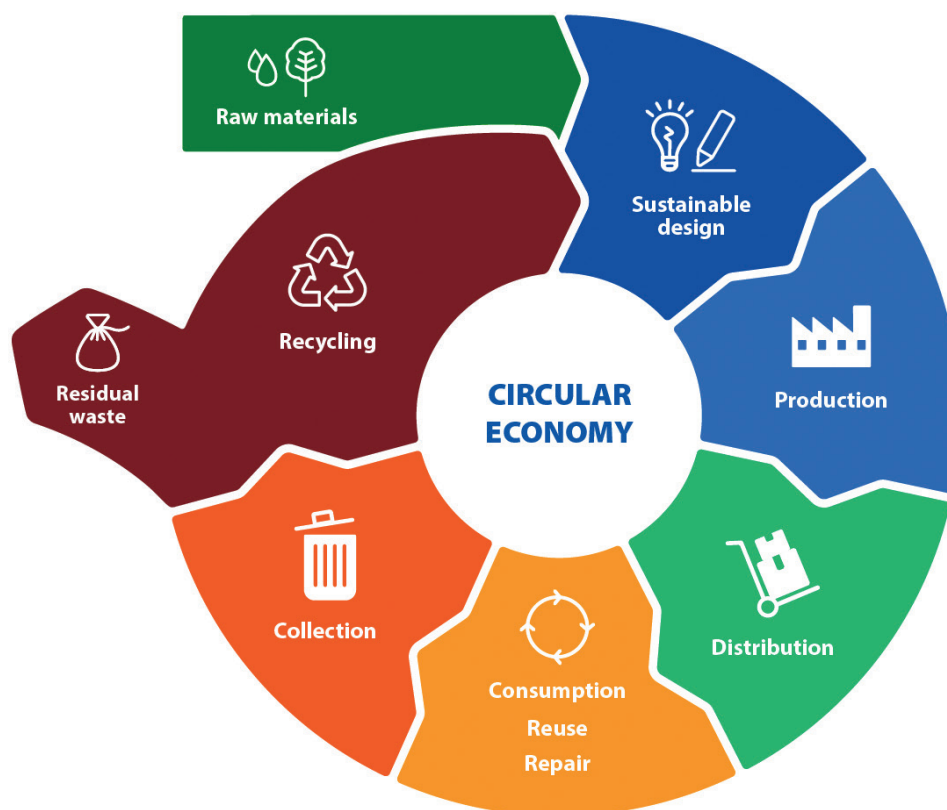


Fig. 4: The Circular Economy Source: European Parliament

The EU has long had a strong commitment to the concept of the circular economy and is currently pursuing the 'European Green Deal' strategy which has the circular economy at its heart.

Over recent decades the Union has sought to promote its vision of the circular economy through regulation and legislation as well as policy initiatives. An example of the latter was the adoption of the 'waste hierarchy', i.e. Reuse, Recycle, Recover. This in turn led to a fleet of directives that sought to enforce the policy. Thus, the WEEE (Waste from Electrical and Electronic Equipment) directive was issued in the early 2000s. The directive has been partially successful in that it has led to the development of an end of life product recovery system and is a significant and highly visible step in the development of a circular economy.

While this approach has achieved much over the past quarter century there is still room for considerable improvement. The amount of *Reuse* achieved in many sectors is often minimal and recovery through *Recycling*

tends to be limited to easily salvageable or especially valuable materials or components. Too much potentially valuable material is still consigned to disposal.

A step change is required. Ultimately products will have to be (re)designed with reuse and recovery in mind, i.e. the concept of 'waste' will effectively be 'designed out'. Products will also have to be designed to be 'smart' or 'intelligent': that is, they will carry with them a profile of their design, constituent parts, history of use and service and this information can then be made available to support upgrading, reuse, recovery at 'end of life'.

All of this is readily technically possible using readily available RFID technology and embedded sensor and memory devices. Nano-technologies and micro sensors – seen in the emerging Internet of Things (IoT) – together with memory chips in consumer and capital good products can be combined with design for reuse, disassembly and recycling to facilitate the development of the circular economy.

The effort and investment required to develop and put in place the technical systems and associated business infrastructure and processes to realise a true circular economy for products is undoubtedly enormous. It will also require significant innovation to achieve the levels of dematerialisation require, i.e. delivering the same product or service using a percentage or none of the mass or material types as hitherto.

The development of the circular economy is certain however to be a source of significant opportunities for future employment in a broad range of specialisms.

In a recently published document entitled ‘*Circular Economy Action Plan*’, the European Commission seeks to create “*a cleaner and more competitive Europe*”. The plan argues that the scaling up of the circular economy will make a decisive contribution to the achievement of climate neutrality by 2050 and the decoupling of economic growth from the use of primary resources. The Plan estimates that implementing circularity principles will increase the EU’s GDP by 0.5% by 2030 while creating 700,000 new jobs.

Recognising that 80% of a product’s environmental impacts are determined at the design phase the Commission intends to propose a sustainable product policy legislative initiative to make products fit for a ‘*climate – neutral, resource efficient circular economy*’. The intention is to widen the Ecodesign Directive beyond energy related products.

2.4.3 Digitalisation and the Circular Economy

Digitalisation, the conversion of analogue processes to digital, has a major role to play in the development and realisation of a truly ‘circular’ products and the creation of a circular economy. Digitalisation will assist enormously in the migration from an economic and industrial model based on **Design–Manufacture–Distribute–Consume–Discard** to one founded on **Design–Manufacture–Distribute–Consume–Return–Disassemble–Reuse/Recycle/Reclaim**.

A transition on this scale will require a major paradigm shift in public policy, human behaviour, economic thinking and analysis, engineering design and a host of other areas – including of course the development of new ‘circular’ industrial systems.

The move to a circular economy and the development of the industrial and logistics infrastructure to support it, over the next 20 to 30 years, will likely generate considerable employment opportunities in engineering, information technology, logistics, manufacturing and many other fields.

The emerging circular economy will be built on sophisticated information technology platforms which will, in turn, challenge these technologies and thereby open up related opportunities in data capture, data analytics, artificial intelligence and robotics.

Acatech, the German Academy of Engineering, recently produced an analysis of the challenges and opportunities presented by the emerging circular economy, focusing in particular on the business models which might underpin it.²⁴

Acatech concludes that “*Business models are a key lever for companies to embrace...ideally a business model aligns circular value creation activities with opportunities to capture economic value*”. The report further concludes that “*optimisation and profit maximisation of individual actors and business models no longer satisfies the demands of a Circular Economy...transforming existing value chains into value cycles requires a holistic view.... and the business models of actors within the value cycle have to be aligned..*”.

Acatech describes the development of a system that evaluates the condition of returned components with the help of AI. Currently, the identification and evaluation process in remanufacturing is largely manual and the process has generally been deemed too complex for automated data processing due to lack of identifiable part numbers, dirt, corrosion and general wear and tear. Skilled workers are needed to support the process but are time –limited and prone to error. The remanufacturing of low value parts was therefore not economically attractive. However digital sensor technology is now poised to resolve this problem and revolutionise the viability of the whole undertaking.

Ultimately if they are to be successful and sustainable, circular business models must simultaneously generate economic value for the individual actors as well as making a systemic contribution to the development of a truly circular value cycle. Acatech rightly argues for the alignment of the digitalisation process associated with

²⁴ <https://en.acatech.de/topic/circular-economy/>

Industry 4.0 with the drive to a circular economy. Those digitally-enabled solutions can help to dematerialise our economy - for example by increasingly selling services to the end customer instead of material products, i.e. servitisation.

2.4.4 Ireland's Approach to the Circular Economy

Ireland's approach to the emergence of a circular economy is well articulated in a paper entitled '*Whole of Government Circular Economy Strategy 2021–2022*'. The National Waste Prevention Programme is led by the Environmental Protection Agency and prioritises food waste, construction and demolition, plastics, agriculture, resources and raw materials. The Programme will be reorganised to become Ireland's national Circular Economy Programme.

In 2019, Ireland's circular material use rate (which measures the share of material recovered and fed back into the economy in overall material use) was the second worst in the EU at 1.6% as compared to an EU average of 11.9%. The Netherlands achieved a rate of 28.5%, a figure which, to say the least, indicates the existence of a significant potential upside for Ireland in this arena in the years ahead.

Work has now commenced on addressing Ireland's current poor performance with the passage of the Circular Economy and Miscellaneous Provisions Act 2022. The Act defines the circular economy for the first time in Irish domestic law as being "*an economic model and policies which give effect to that model*". The relevant policies identified include the minimisation of the consumption of raw materials, the extraction of the maximum economic value from goods, services and materials and the recovery and regeneration of the latter at the end of their useful life.

The aims of the circular economy clearly entwine with those of the decarbonisation agenda and this is reflected in legislation and Government policy. Thus, in the Climate Action Plan 2023 Annex of Actions, the Government sets out a range of actions relating to the development of the circular economy. These include the publication of a "*2nd whole-of-Government Circular Economy Strategy setting out an overall national policy in relation to circular economy*" by Q4 2023. Other commitments which point to the future include:

"Action Number CE/23/3 (Q3/4 2023)

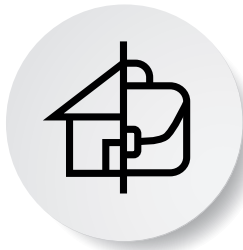
Reduce demand for virgin raw materials and support re-use, by keeping material out of waste streams through streamlined end-of-waste and by-product decision-making processes and national end-of-waste decisions for specific construction and demolition waste streams".

Action Number CE/23/4 (Q4 2023)

"Continue to drive the rollout of CirculÉire, the national programme for circular manufacturing and innovation".

*CirculÉire, quoting the EPA, estimates that 100 million tonnes of material are used annually in the Irish economy and "implementing a 5% material improvement across the economy would represent an annual €2.32bn opportunity". The campaign aims to capitalise on this opportunity by "highlighting circularity knowledge, capacity building and implementation gaps..".*²⁵

²⁵ <https://circuleire.ie/the-circular-economy/#benefits>



2.5 Remote Working

2.5.1 Introduction

The COVID-19 global pandemic was a catalyst, out of necessity, for remote working – at least in the short term. The initiative has proved popular and likely enduring as people of all ages and backgrounds embrace Zoom and Teams and other videoconferencing systems.



Fig. 5: Remote Working

As workers continue to seek remote working or working-from-home (WFH) options and its hybrid variants, companies are having to consider the longer-term implications. Many are turning to experts for advice on such matters as, in order to be effective, a remote work strategy needs careful and thoughtful design. Corporate employment policies and operational practice may require changes or adaptations if desired levels of worker satisfaction and productivity are to be achieved and maintained.

2.5.2 Background

Modern technology makes it possible to work in unconventional ways, and the job market is evolving dramatically because of this. Many companies recognise the benefits of remote-based work, and the number of flexible jobs will probably continue to steadily increase. Remote working can give a renewed boost to cooperation

and cohesion. Investing in remote working will have far-reaching consequences on the way we work after the crisis.

Remote work is work done outside of a traditional office environment. The basic concept of remote work is simple and it is that employees can successfully execute projects and daily tasks without needing to commute to an office each day.

Different levels of remote employment opportunities exist, but each type provides the benefit of flexibility in an employee's professional and personal life.

Though there are somewhat different perspectives on the advantages and disadvantages of the remote working there is a slowly emerging consensus as represented in Table 1.

	Employees	Employers
Advantages	Flexible lifestyle	Higher productivity – or at least no fall in productivity
	Improvements in physical and mental health	Cost savings
	Renewed passion for the job	Engaged employees
Disadvantages	Isolation from peers and “the team”	Potential distractions
	Requires greater self-motivation	Lack of “community”
	Reduced access to mentors	Possible fall in accountability

Table 1: Some Pros and Cons of Remote Working

2.5.3 Global Perspectives

According to a recent survey of Chief Human Resource Officers carried out for the World Economic Forum, some 44% of workers, on average, worked remotely during the COVID-19 pandemic.²⁶ A majority of business leaders surveyed (78%) expect some negative impact of the current way of working on productivity, with 22% expecting a strong negative impact and only 15% believing that it will have no impact or a positive impact on productivity. It was also concluded that those working from home could face mental health and well-being challenges, including childcare pressures and digital connectivity.

In a somewhat sceptical *New York Times* article²⁷ the author noted that many senior executives believed that “operating from home is simply less productive than being in the office”. The article continued:

“Collaboration is harder, as is mentorship. That short stroll to a colleague’s desk to ask a quick question or make a request becomes a laborious process. Working remotely ‘doesn’t work for young kids or spontaneity or management,” Jamie Dimon, the chairman and chief executive of JPMorgan, said in January at the World Economic Forum’s annual meeting in Davos”.

The author observed that “...the notion of flexible work is a form of white-collar privilege. Americans who labor in factories or in restaurants or stores don’t have the luxury of working from home”. She continues that the U.S. should be aware of different choices being made by other countries, particularly China where the expression “996” means working 9am to 9pm, 6 days a week.

The author accepts that time spent commuting “can be considered wasted” and that “new technology, particularly video conferencing, has made remote work more feasible...”.

It seems many U.S. companies have reluctantly accepted that the future will involve working from home with attendance in the office “for perhaps three of four days a week and never on a Friday”.

The Stanford University economist, Professor Nick Bloom, has undertaken considerable research into international experience of and attitudes to remote working and his advice on the subject is followed widely by companies.²⁸

Prof. Bloom’s findings are useful to note. He found that the hybrid approach to remote working (some days in office, others at home) was highly valued by employees on average, reducing attrition by 33% and improving job-satisfaction measures. Also, hybrid solutions reduced

²⁶ World Economic Forum, *Future of Jobs Report 2020*

²⁷ March 22nd 2023

²⁸ See for example: Bloom, N. et al, *How Hybrid Working from Home Works Out*, Working Paper 30292, National Bureau of Economic Research, Jan 2023

working hours on home days and increased them on office days and the weekend, altering the structure of the working week.

He noted that hybrid practice increased messaging and video calls, even when all employees were in the office, reflecting a move towards more electronic communication.

Finally, he found “*large differences in the valuations of hybrid between managers and non-managers*”. Non-managers were more likely to volunteer into the hybrid experiment, to work from home on eligible days, to predict positive impacts on productivity, and to reduce their attrition under hybrid. In contrast, managers were less likely to volunteer, less likely to work from home on eligible days, predicted a negative average impact of hybrid on productivity, and saw increased attrition rates under hybrid.

Prof. Bloom concluded that the evidence shows a mix of working from home and in the office is “*win-win*” and “*it doesn’t make sense to go back to five days a week*”.²⁹

2.5.4 Ireland's Perspective

As elsewhere, COVID-19 greatly accelerated reliance on remote working and brought the concept to the forefront of working life in Ireland. It is likely to remain a central part of the workplace into the future.

As David McWilliams pointed out in a recent *Irish Times* article³⁰ the spread of a decent standard of broadband is allowing an increasing number of people to decide to re-locate to parts of rural Ireland that were hitherto out of bounds for remote working purposes for reasons of connectivity. McWilliams says that 45.7% of those who left Dublin in the period 2011-2016 were aged 20-34, i.e. those starting their careers, and this trend may have continued post pandemic.

The CSO data indicate that more than eight in 10 (85%) of those in employment whose job could be done remotely but who did not work remotely prior to the pandemic said they would like to do so when pandemic restrictions are no longer in place. This proportion increased to 96% for employees who did work remotely some of the time and to 97% for those who worked remotely all the time before the pandemic.

The European Central Bank has come to similar conclusions based on a recent study.³¹ The bank found that nearly one third of Eurozone workers want more remote working. Two-thirds of EU employees want to work from home at least one day per week. Commuting, or its avoidance, is the main driver of these views and those with longer commutes desire noticeably more remote working than those living closer to the office or workplace.

The Irish Government issued a strategy document on the subject in early 2021 entitled ‘*Making Remote Work: A National Remote Work Strategy*’.

The Strategy cautions that whilst the arrangement has been beneficial for some, it is important not to conflate the experience of home working during the COVID-19 pandemic with remote working under normal conditions. The sudden introduction of mass emergency home working often resulted in less than ideal working conditions for both employers and employees. Significant challenges faced over the pandemic period have included a lack of adequate remote working infrastructure, unsuitable home working environments and, at times, the non-availability of early learning childcare and schooling.

Despite these substantial challenges, the interest in continuing remote working in the longer term remains strong amongst employees. Research carried out in October 2020 found that 94 percent of participants would like to work remotely after the crisis. This figure is almost 10 percent higher than it was in the first phase of the research published in May of the same year.

The Strategy aims to build on the progress made in the adoption of remote work over this period. The objective is to ensure that remote working is a permanent feature in the Irish workplace in a way that maximises economic, social and environmental benefits.

Public policy has an important role to play in the realisation of this vision. As outlined in the 2019 DETE report “*Remote Work in Ireland*”, there are multiple benefits that can be derived from remote work which will help to achieve numerous public policy objectives. These include:

²⁹ See also Clark, P., *Financial Times*, 27th March 2023

³⁰ *Irish Times*, 11th March 2023

³¹ ECB, *European Interest*, 17 February 2023

- ▲ increasing participation in the labour market
- ▲ attracting and retaining talent
- ▲ enabling balanced regional development
- ▲ alleviating accommodation pressures
- ▲ improving work/life balance
- ▲ improving child and family wellbeing
- ▲ reducing the amount of time spent commuting
- ▲ reducing transport-related carbon emissions and air pollution.

The impacts of increased remote work can be substantial and remote working has the potential to fundamentally change the nature of where, how, when and why people work. This in turn can bring about economic, spatial, environmental, cultural and societal change.

However, the increased adoption of remote work is not without difficulty. Research has highlighted different impacts for employees and employers. In the case of employees, remote working is linked with negative effects on mental health, with workers experiencing feelings of isolation, loneliness and stress. Employees also experience difficulty switching off and keeping regular working hours.

A further effect of this megatrend is to be found in its impact on our major town and cities as demand for office space falls. This effect is already a reality in Dublin.³² The decline can be quite significant and will have implications, as yet unseen, for urban land use and zoning decisions – including the possible re-purposing of existing office accommodation to other uses, including housing.

The Irish approach to remote working seeks to promote information sharing while ensuring alignment with the wider policy goals of the State. The latter are multi-dimensional and include increasing participation in the labour force, balancing regional development, enhancing public transport infrastructure and usage, carbon mitigation, improving child and family wellbeing, increasing the supply of affordable homes and improving work/life balance.

2.5.5 Changing the Competitive Dynamic

Remote and hybrid working can change the competitive dynamic between cities and regions and indeed between individual countries. If, as seems likely, remote or hybrid working in some form remains a reality, talented people have a greater choice as to where they live, almost irrespective of where they work. This is a revolutionary change. It is clear that cities, regions or countries offering a perceived enhanced quality of life and not simply standard of life can and will be big winners in the competition for higher end employment, in particular.

This includes the so-called “digital nomads”, i.e. entrepreneurs and others who can function permanently from virtually anywhere in the world – or rather, anywhere with a reliable internet connection. As the Harvard Business Review³³ has recently pointed out many countries and regions are already competing to attract such nomads.

Areas that attract and retain top talent will inevitably move from the periphery to the centre of activity. This trend unleashes complex dynamics that are still not fully understood – especially where Ireland is concerned.

In the past many jobs were located in Ireland due to our success in attracting leading global players. This success has brought prosperity but has also contributed in some measure to the problems associated with the availability and affordability of housing in Dublin and other cities. Such difficulties impact on quality of life and can in turn generate negative feedback that places queries against the desirability of Ireland as a place for companies to invest or individuals to live, work and raise a family. The remote working revolution cuts across all of these issues.

In this context a recent Dublin Chamber of Commerce survey undertaken as part of “*Dublin 2050 a Vision for Dublin*” is instructive. The survey sought to capture the aspirations of Dubliners and the findings are relevant to making the city an attractive place to live and work while providing some guidance around the services and jobs required in the future.

Respondents were asked to rate the importance of a number of factors to the quality of life in 2050. A selection of the results obtained included:

³² <https://www.cbre.com/insights/figures/dublin-office-market-overview-q1-2023>

³³ <https://hbr.org/2023/02/how-to-become-a-digital-nomad>

- ▶ 89% - a world class education system available to all
- ▶ 89% - a world class healthcare system
- ▶ 87% - a great place to bring up children
- ▶ 86% - Dublin will be a great place to grow old
- ▶ 86% - Dublin will have world class public transport
- ▶ 84% - everyone will be able to afford to rent a home
- ▶ 83% - Dublin will be a great place to work.

Clearly, the aspirations of Dubliners – and by extension of Irish people in general – do not lack ambition. But these are precisely the factors that will help to differentiate Dublin and Ireland amongst potential competitors.

There is still considerable uncertainty surrounding the medium and longer term effects of remote working in practice. For example, while Ireland may still continue to attract high quality FDI investment in future it may not be accompanied with the same level of onshore employment as heretofore depending on the level of remote working practised in individual companies.

It seems clear that a precautionary approach should be adopted by Government to this issue with a goal of ensuring that Ireland remains an attractive place for employees whether working remotely or not. A strategy is required that identifies Ireland as an attractive and desirable place for increasingly mobile international talent to reside and work. Delivering on the aspirations identified in the Dublin Chamber survey for both domestic and overseas workers should be a key priority for Irish industrial policy and economic planning in the coming decades. This will require a whole-of Government approach and a commitment to enhancing “quality of life” factors in a coordinated, determined and deliberate manner that has not perhaps been an evident aspect of our strategies to date.

The longer-term future of remote working will depend on a broad range of factors, including its effect on productivity and working conditions, as well as its contribution to broader policy objectives such as Europe’s digital and green transitions.

Some evidence suggests that in normal times people working from home can sustain, or even enhance, their productivity, while enjoying a better work-life balance.³⁴ It is clear that the maintenance of productivity and good working conditions for many workers depends on access to childcare and suitable working spaces and ICT tools.

Policies designed to support more widespread remote working will need to carefully consider both the potential benefits including those relating to employee work-life balance and mental and physical wellbeing as well as the costs, if any, in terms of lost or diminished productivity, job satisfaction, mentoring opportunities and corporate culture.

The approach taken to remote working will inevitably vary considerably with the sector and organisation – after all many sectors such as hospitality could not sustain the practice. However, it is clear that remote or hybrid working is more than just an employee perk, it is now an established part of the ordinary working week and a fact of life for millions of people worldwide.

34 <https://www.businessnewsdaily.com/15259-working-from-home-more-productive.html>

3. CONCLUSIONS AND RECOMMENDATIONS

This is a pivotal time for the future of our society. In common with the rest of the developed world our prosperity has ultimately been built on the foundations of the carbon economy and this is now the also the source of our potential undoing. Climate change poses an existential threat and Ireland, on its own behalf and as a member state of the European Union, must make achieve sufficient progress on decarbonisation to enable the “net zero” goal to be met by 2050.

Achieving this target will require the prodigious expenditure of capital, both financial and political, as well as a transformation of our long-established ways of living and working. The process of change has already sparked a search for innovative solutions and research and development programmes will stimulate this further.

Investment will be required in renewable energy, in building the circular economy and in developing a myriad of related and derived new technologies and processes that will re-shape our society as well as the nature of work and employment in the period to 2040 and beyond.

In facing this future, Ireland, as a small open economy, will require a steady supply of creative and innovative thinkers capable of complex problem solving and with the initiative to drive innovation in a broad range of specialisms. Our higher level educational institutions will be the incubators of much of the required talent, augmented by publicly and privately funded research facilities, and this fact has obvious and profound implications for all of those bodies.

An important output from all of this creative activity will be market-led, internationally competitive products and services.

As part of the process positive, flexible approaches to remote and hybrid working can make Ireland an attractive location for mobile talent; talent that can boost our success by leading in areas like decarbonisation, the circular economy and Industry 4.0. If managed well, the remote working phenomenon can also make a major contribution to increasing participation in the labour force, balanced regional development, carbon mitigation, improving child and family wellbeing and improving work/life balance.

A large and growing proportion of the Irish workforce is currently employed in technology and manufacturing. Multiple converging technologies and Industry 4.0 will change the competitive landscape considerably in the coming years. By investing heavily in these areas and by continually upskilling and reskilling our workforce we can retain our competitive edge. In this way employment levels can be protected and enhanced and wealth can be created, in a sustainable manner, to fund the quality of life and public services that we all desire.

We share the view of the World Economic Forum (WEF) that *‘gains are not a foregone conclusion. They entail difficult transitions for millions of workers and the need for proactive investment in developing a new surge of agile learners and skilled talent globally...there is a virtuous cycle between new technologies and upskilling’*.

The Academy believes Ireland is well positioned to create and benefit from this virtuous cycle.

The global “megatrends” reviewed above present a classic case of challenge and opportunity from the perspective of the Irish economy. That significant challenges are looming – or already in evidence - cannot be doubted. Equally, real opportunities will be presented for the betterment of our society and our economy.

In seeking to navigate the dangers and seize the opportunities in this rapidly emerging landscape the Academy proposes the following recommendations to policy-formers and decision-makers.

1. Raise awareness

Ireland is fortunate to have a strong enterprise base. The country has built strong manufacturing and service capabilities over decades and hosts a disproportionate share of top global firms in high tech industries. However global trends in converging technologies, new business models as a result of industry 4.0 and circular manufacturing will disrupt the existing base. There is no room for complacency. There is a real threat to our base and to our existing economic model. Government, educators and employer/employee bodies must raise awareness of the scale of change, investment and reskilling required over the coming decades.

2. Create a culture of innovation

Many of the challenges facing society and the economy will require innovative solutions. Achieving decarbonisation to the extent required for net zero will not be possible using only today's technologies. Ireland is fortunate to have wind resources that has allowed us already to be a leader in renewable energy. Other opportunities exist in this sector such as solar, offshore wind and perhaps, in time, wave energy. Our scale is such that we can act as a 'sand box' for new or innovative models of sustainable energy production or manufacturing. Ireland is small enough to trial new technologies and yet big enough to prove them.

In the last 20 years national competitiveness has been improved through the technology centres of Enterprise Ireland/IDA and the research centres of Science Foundation Ireland. These centres aligned well to the priority areas identified by Government thereby successfully driving economic activity. We now need to revisit our priorities and funding for research in the light of the emerging disruptive technology changes to ensure an optimum alignment is achieved and maintained with global trends.

By fostering a strong culture of innovation Ireland can best respond to challenges as they emerge. We need to encourage agility, flexibility and creativity. To maintain a focus on innovation, the Academy believes that Ireland should establish an Innovation Council. The Academy has set out its position on this matter in more detail in a previous publication.³⁵

³⁵ Innovation Council – A Proposal, April 2021 at www.iae.ie

3. Make Ireland a location of choice

Remote and hybrid working can change the competitive dynamic between cities and regions and indeed between individual countries. Talented people can now have a greater say in where they want to live. Therefore those regions and countries that offer a better lifestyle can be big winners in the competition for peripatetic talent. Cities and regions that are open, diverse and collaborative have long been dynamic engines of economic growth.

With the right vision and the creation of strong digital collaboration and networking tools all of the island of Ireland can be attractive as a connected region; a region that offers a preferred location for living and working. The COVID-19 pandemic led many to reevaluate their life choices, including where they live. To make Ireland a location of choice for creative, innovative talent we must now develop and promote a lifestyle value proposition around infrastructure, the environment, housing, health, leisure and transport; in short “quality of life”. Technology can allow those living and working in Ireland to move (virtually) from the periphery of global economic activity to the centre.

4. Invest in Education/Skills

Global trends will force difficult transitions for many workers. These transitions require proactive investment in developing a new surge of agile learners and skilled talent. Our third level educational institutions have a critical part to play in delivering on this objective. The education and research activities in such institutions can drive creativity and innovation.

Top class graduates are the raw material required to navigate and benefit from global changes. Higher level institutions should continue to enhance their versatility and be ready to change course material to meet industries needs for lifelong learning. In addition they should develop apprentice certification in relevant energy and digital domains. Irish higher level institutions are underfunded by international standards resulting in inadequate infrastructure and unsustainable staff student ratios. The funding model for this sector needs to be addressed and reformed to allow Ireland to reach its full potential and benefit from the emerging global megatrends.



Disclaimer

The members of the Taskforce and the contributors participated in extensive discussions in the course of a series of meetings, and submitted comments on a series of draft reports. This report represents the collective view of the Academy, and its recommendations do not necessarily reflect a common position reached by all members of the Taskforce and do not necessarily reflect the views of individual members of the Taskforce, nor do they necessarily reflect the views of the organisations to which they belong.



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