matrix.
Northern Ireland
Science Industry Panel

Future Skills: Scenarios for the NI Economy

Foreword

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In July 2019 the Department for Economy published a pivotal report by David Skilling, exploring the strategic integration of skills and innovation policy for Northern Ireland. Combined with the department's economic vision, the Matrix panel recognised the underpinning role of skills in catalysing rapid advancements in science, technology, translational research and applied innovation. This future focused report explores diverse scenarios that, as noted in the Skilling Report of 2019, can take multiple forms and have varied socio-economic impacts.

Northern Ireland boasts one of Europe's youngest populations with over 50% of the population under 40, high levels of graduate-led start-ups and a third of 16-64 year olds attaining university education. This foresight report provides insight into how Northern Ireland could leverage these strengths and address the persistent challenges of economic activity, inclusivity and place-based inequalities.

Examining potential scenarios reveals varying impacts, from exacerbating inclusivity issues to propelling Northern Ireland forward, bolstering economic output and international engagement. Across sectors and scenarios, the report identifies consistent skills needs: adaptability, AI and machine learning proficiency, collaborative working, critical thinking/problem solving, data analytics, and effective communication. These must be complemented by ongoing development in ethical practices, cybersecurity skills, and quality assurance, ensuring a robust current and future workforce.

Foreword

The report findings indicate a great deal of commonality across roles, regardless of industry, reinforcing the requirement for digital literacy amongst all employees and the critical support required for developing fundamental life skills. The report also highlights the pivotal role of current and future policy development in shaping workforce skill development and cultivating organisations comfortable with technology, data, change, and lifelong learning, particularly in the context of Artificial Intelligence.

Emerging technologies are reshaping our economy's skills landscape by increasing demand for roles related to AI development, data science, and machine learning. However, these technologies could potentially displace certain routine tasks, necessitating a focus on the requirement for upskilling in more complex, non-routine areas.

AI, and Generative AI in particular, accelerates the pace of change by automating tasks, fostering innovation, and creating new possibilities. This rapid evolution challenges industries to adapt swiftly, prompting the need for continuous learning and flexibility in navigating technological advancements. The transformative speed of generative AI demands agile responses from individuals, businesses, and societies - this focus is outside of the remit of this work.

The report was completed before the restoration of the Northern Ireland Executive in February 2024, and it continues to serve as a valuable guide for anticipating the future skills needs of the Northern Ireland economy in the innovation intense sectors.

Contents

1. In 2020, Matrix commissioned Firetail to conduct a futures study on the Technology and High Technology Skills and Workforce needs Northern Ireland might face in the decade to 2035.

2. This report offers a refresh of Firetail's study and takes account of DfE's skills strategy

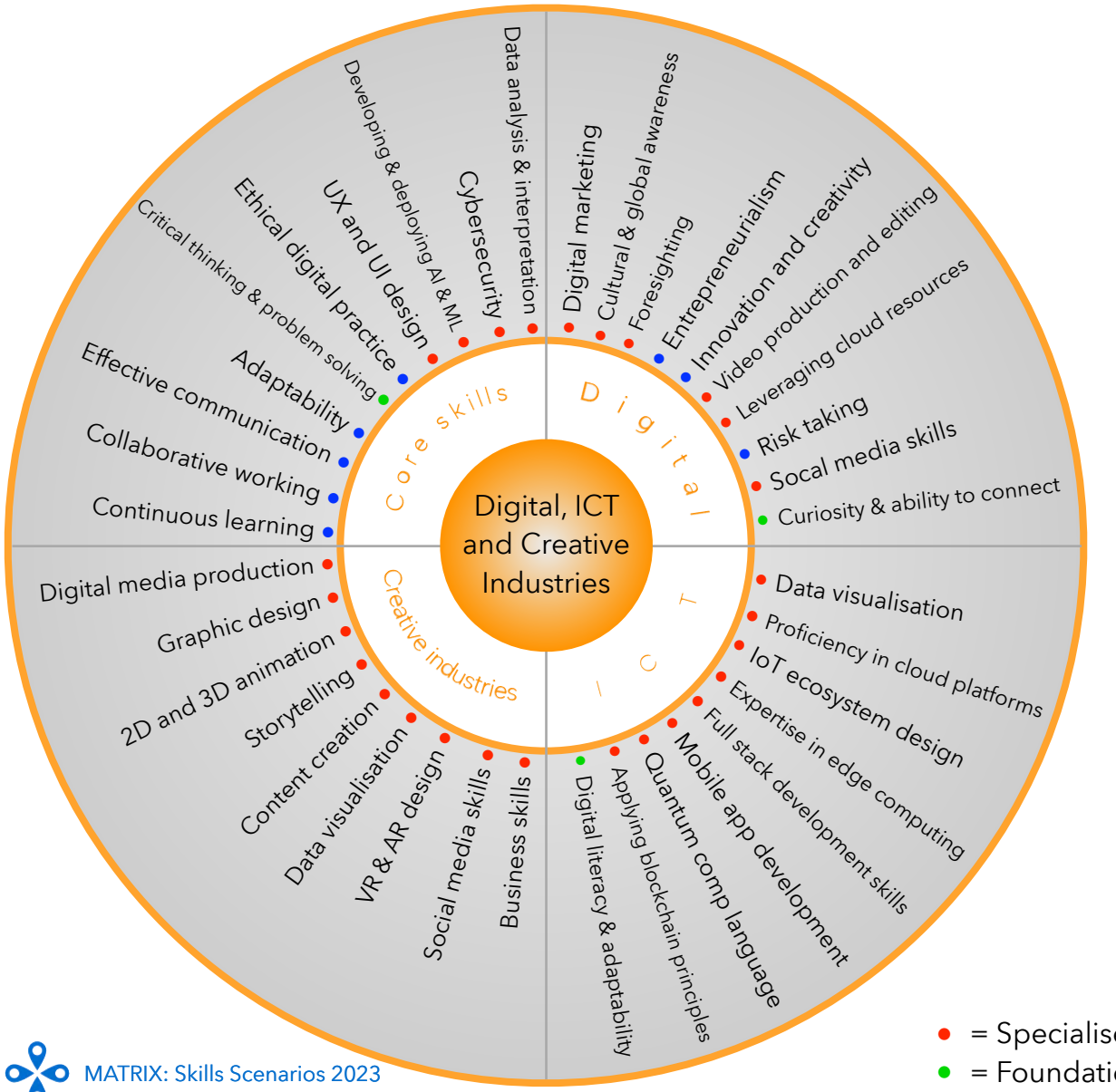
3. The report contains 7 sections:

- Section 1 introduces the report
- Section 2 sets out the strategic context for Northern Ireland
- Section 3 presents our analysis of the skills that will be required in each of the innovation intense sectors.
- Section 4 describes how the scenarios were developed by Firetail and how they have been adjusted in this report
- Section 5 present the scenario and a range of key metrics
- Section 6 sets out our analysis of the key issues highlighted in the report
- Section 7 offers a final set of recommendations

4. The report utilises the World Bank's typology of skills required for future success:

- Foundational and higher order skills, which are specialised skills that encompass the ability to understand complex ideas, adapt effectively to the environment, learn from experience, and reason.
- Socio-emotional skills, which describe the ability to manage relationships, emotions, and attitudes. These skills include being able to navigate interpersonal and social situations effectively, as well as leadership, teamwork, self-control, and determination.
- Specialised skills, which refer to the acquired knowledge, expertise, and interactions needed to perform a specific task, including the mastery of required materials, tools, or technologies.

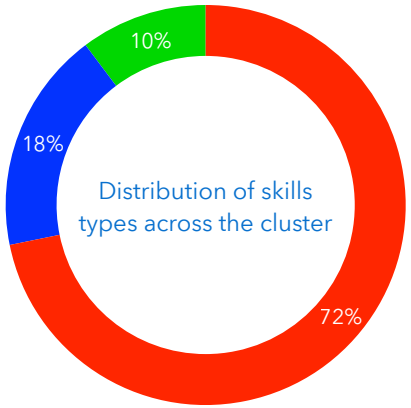
The skills that will be required in each of NI's innovation intense sectors are shown on pages 6-10.



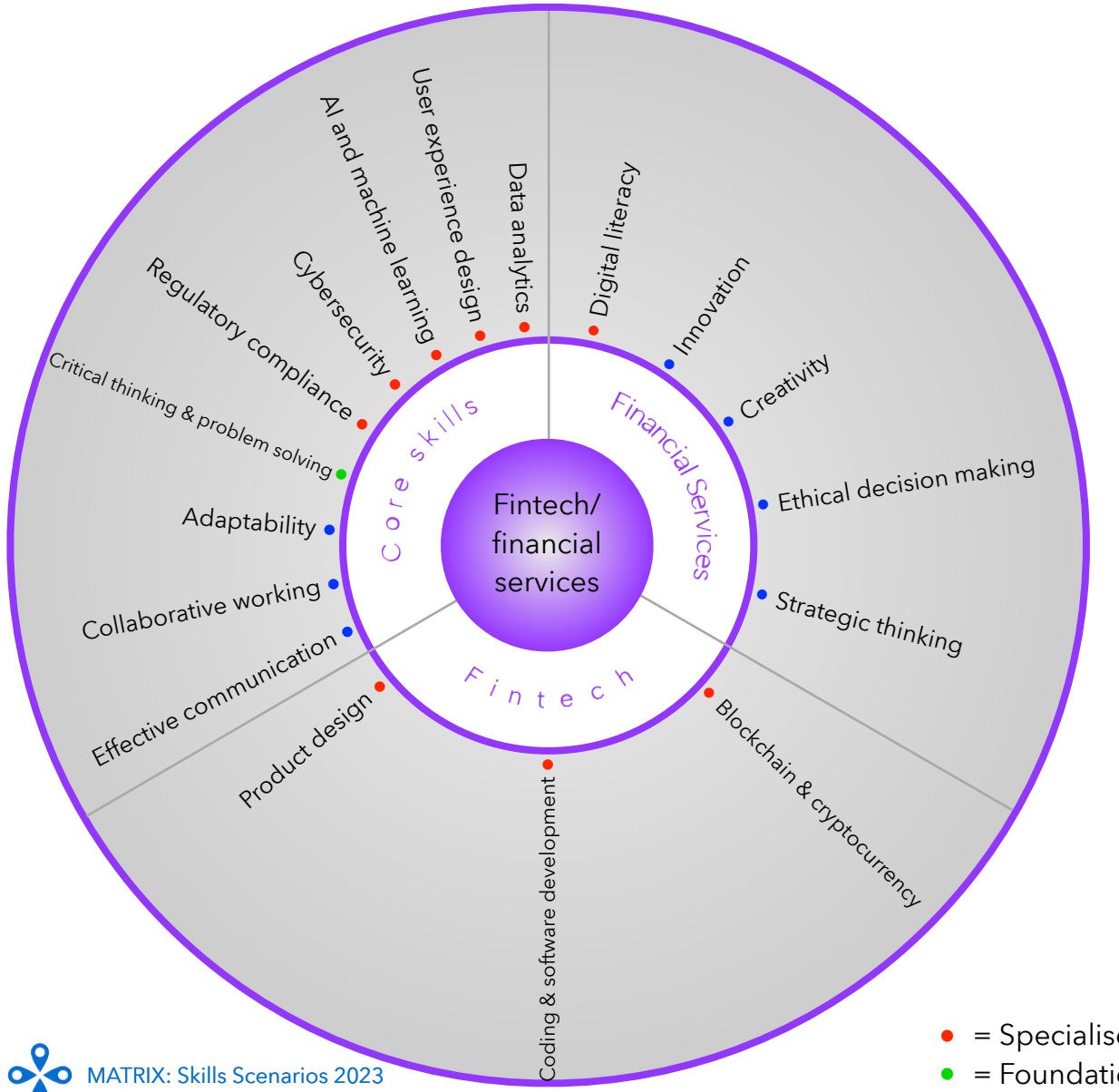
The skills required for future success in the Digital, ICT and Creative Industries priority cluster fall into four categories:

- Digital
- ICT
- Creative industries
- 'Core skills' - that is, skills which are required in all 3 sectors in the cluster (Digital, ICT and Creative Industries)

There are 10 core skills of which 4 are specialised skills, 1 is a foundational and higher order skill and 4 are socio-emotional skills.



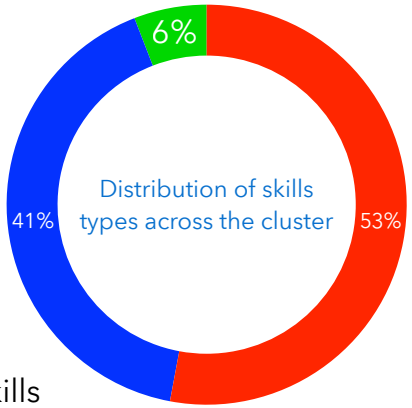
- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills



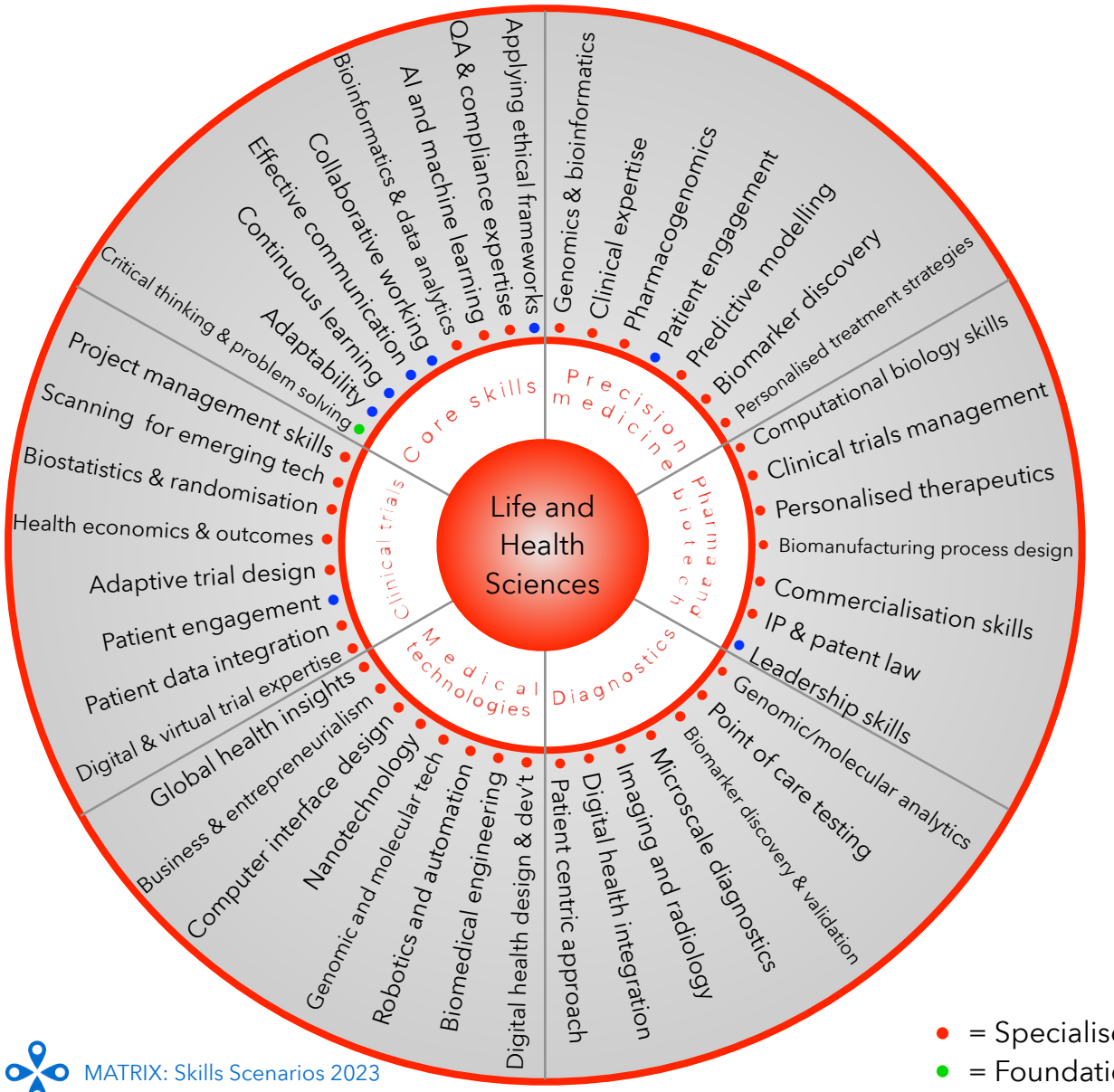
The skills required for future success in the Fintech/Financial Services cluster fall into three categories

- Fintech
- Financial services
- 'Core skills' - that is, skills which are required in both sectors in the cluster(Fintech, Financial Services)

There are 9 core skills: 5 are specialised skills, 1 is foundational and higher order and 3 are socio-emotional skills.



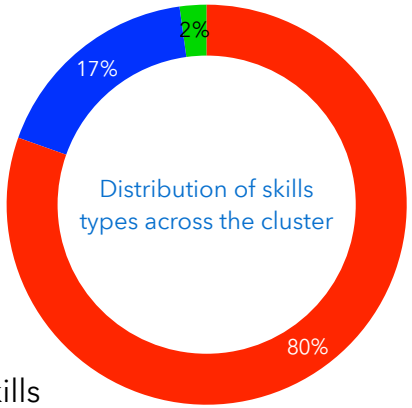
- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills



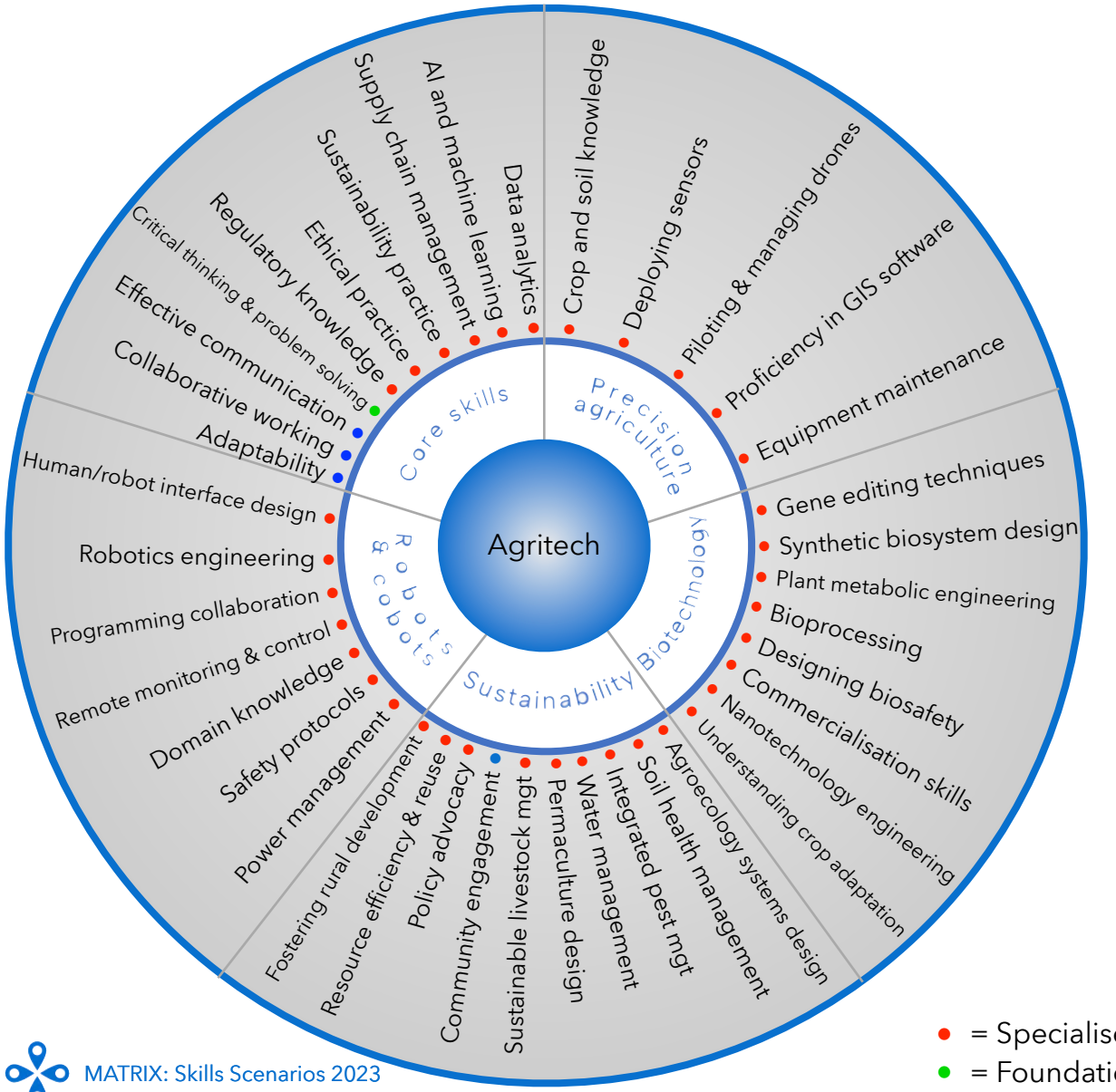
The skills required for future success in the Life and Health Sciences cluster fall into six categories

- Precision medicine
- Pharma and biotech
- Diagnostics
- Medical technologies
- Clinical trials
- 'Core skills' - that is, skills which are required in all 5 sectors in the cluster (Precision medicine, Pharma and biotech, Diagnostics, Medical technologies, Clinical trials)

There are 9 core skills: 3 are specialised skills, 1 is a foundational and higher order skill and 4 are socio-emotional skills.



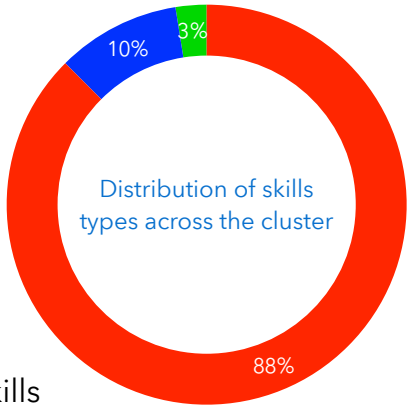
- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills



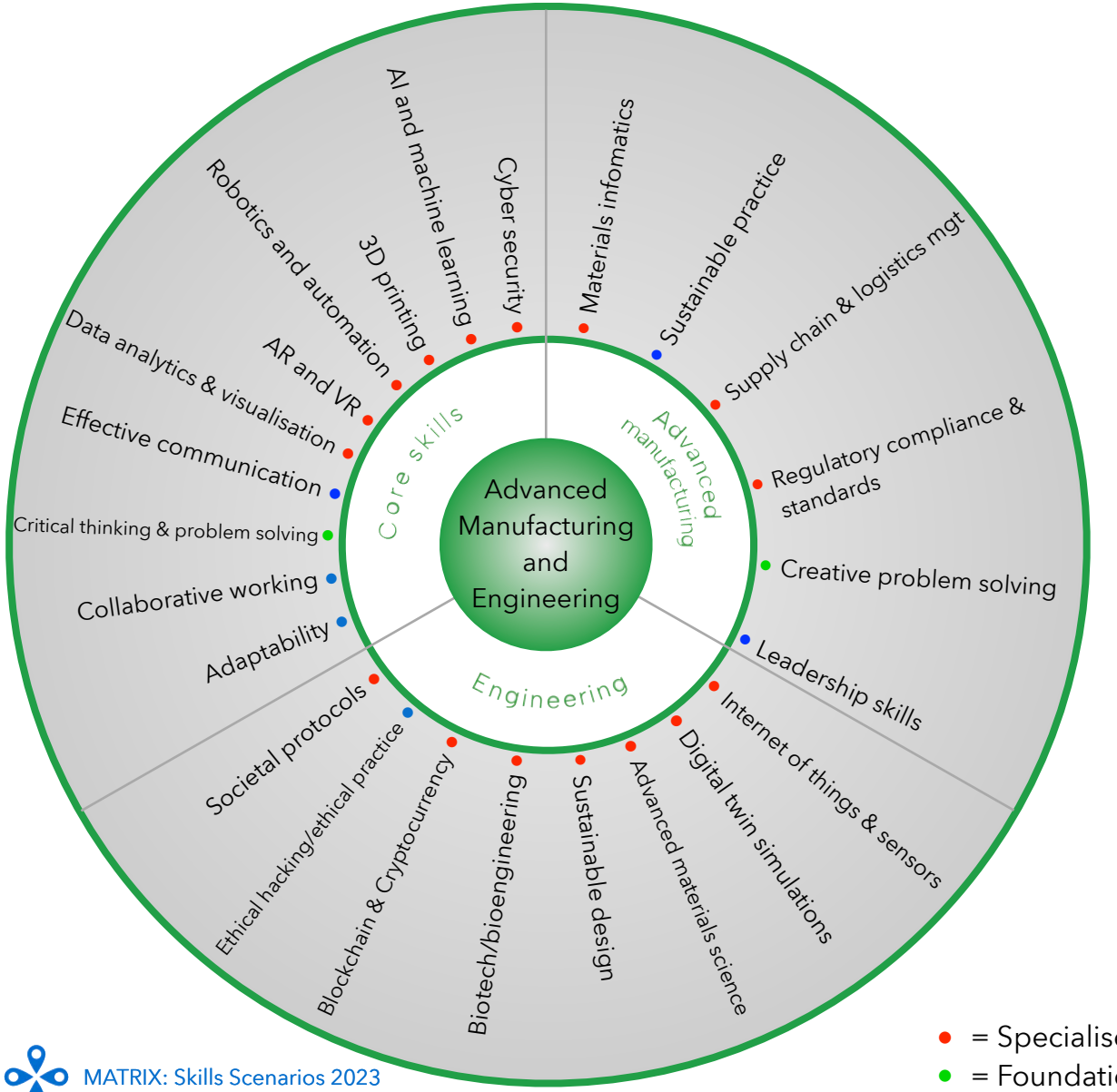
The skills required for future success in the Agritech cluster fall into five categories

- Precision agriculture
- Biotechnology
- Sustainability
- Robots & cobots
- 'Core skills' - that is, skills which are required in all 4 sectors in the cluster (Precision agriculture, Biotechnology, Sustainability, Robots & cobots)

There are 10 core skills: 6 are specialised skills, 1 is a foundational and higher order skill and 3 are socio-emotional skills.



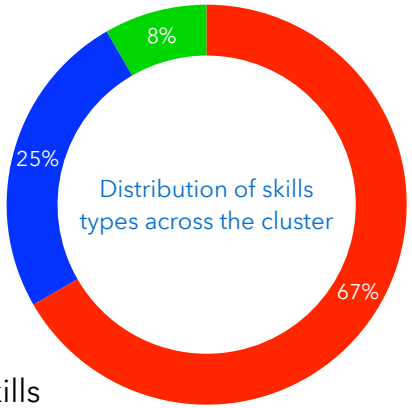
- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills



The skills required for future success in the Advanced Manufacturing and Engineering cluster fall into five categories

- Advanced manufacturing
- Engineering
- 'Core skills' - that is, skills which are required in both sectors in the cluster (Advanced manufacturing, Engineering)

There are 10 core skills: 6 are specialised skills, 1 is a foundational and higher order skill and 3 are socio-emotional skills.



- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills

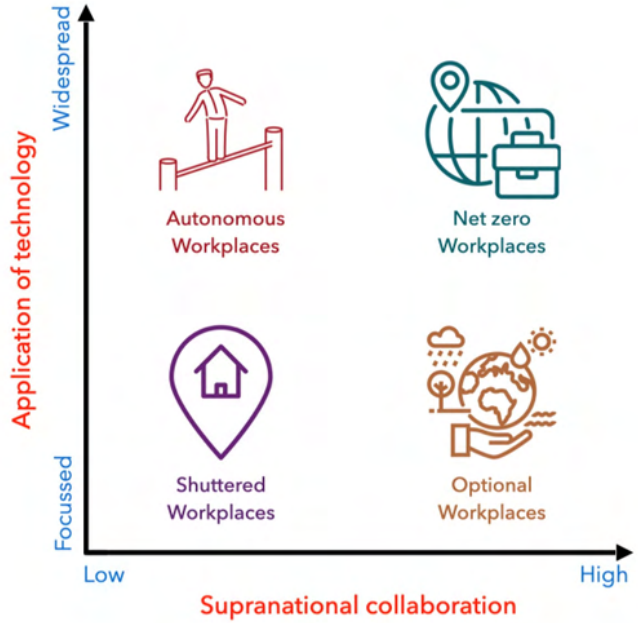
5. The scenario framework highlights the two most critical uncertainties facing the Northern Ireland economy as it looks towards 2035. The first axis - supranational collaboration - relates to the uncertainty surrounding the global response to net zero and other emerging global challenges such as poverty, healthcare and global security. The second axis - application of technology - relates to uncertainty surrounding the uptake and use of technology to tackle global issues and to drive economic growth.

6. The framework defines four alternative scenarios:

Autonomous Workplaces describes a future where the application of technology is widespread and supranational collaboration is low. Technologies are used to manage workflow and cut costs.

Net Zero Workplaces describes a future where the application of technology is widespread and supranational collaboration is high. Corporates and skilled staff work flexibly and move constantly, fuelling city-level competition. Skill shortages and wage inflation accelerate in regions that fail to attract talent.

Optional Workplaces describes a future where the application of technology is focused and supranational collaboration is low. Economic activity and growth have slowed worldwide as governments focus on low carbon living and working. Public funding of technology supports this endeavour.



Shuttered Workplaces describes a future where the application of technology is focused and supranational collaboration is low. The east is on the rise and the west moves in and out of recession as concerns over privacy, equality, bias and resource-intensity cause a societal backlash.

7. The relative importance of the five clusters varies across the four scenarios as illustrated in the tables on pages 12-15.

Prominent technologies in *Autonomous Workplaces*

AI and behavioural science is used to understand sentiments and preferences

Digital personalisation drives competition in consumer markets

Human/computer interfaces increase productivity

e-Government drives cost savings in the public sector

Cybersecurity protects digital footprints, particularly for the most wealthy

Longevity science offers regenerative medicine and cryonics to the ultra wealthy

Personalised health monitoring and advanced diagnostics uses wearable devices and sensors to continuously monitor individual health metrics

Genetic Testing and Precision Medicine identify individuals' genetic predispositions to disease. Personalised therapeutics tailor treatments to genetic makeup, maximising efficacy and minimising side effects

Nanomaterials with unique properties, such as self-cleaning surfaces, enhanced durability, and improved strength-to-weight ratios are used in luxury product

Smart materials are used to create luxury interactive wearables that change colour, display content and provide biometrics

Sustainable luxury items - such as lab grown diamonds, pearls and fabrics - are in demand by global elites wishing to consume sustainably

Commentary

The Digital, ICT and Creative Industries cluster is the key driver of NI's future success in this scenario - although the cluster itself changes due to the limited importance of the creative industries.

Life and Health Sciences and Advanced Manufacturing and Engineering remain important clusters in their own right, with investment directed towards those aspects that support the wider policy goal of making NI a high value service economy.

Agritech and Fintech have less strategic value to NI in this scenario. While this doesn't mean that the clusters will disappear, it does suggest that investment in technology - and the education and training infrastructure - should not prioritise skills development in these areas. Some core skills are, of course, transferrable from other clusters.

Prominent technologies in *Net Zero Workplaces*

Intelligent agriculture is developed by applying sensors/data analytics/internet of things technologies across all stages of the food chain

Low carbon agriculture focusses on reducing emissions through selective breeding, genetically modified feeds and methane inhibitors

Tackling disease resistance and food yields

Protecting and restoring biodiversity

Deploying circular agriculture to put byproducts - from crop residues to dairy manure - back into the system

Cybersecurity is critical for keeping data secure and systems operating

VR and spatial computing solutions are key to virtual collaboration

AI tools support productivity, creativity and task completion

Mobility as a Service keeps travel easy and efficient

Physical health and wellbeing are monitored across the life course. This is a key attractor for NI

Mental health and wellbeing are monitored across the life course. This is used in particular to support workforce productivity

Intelligent induction charging transport infrastructure keeps people moving and batteries charged

Commentary

Success in this scenario - and, more importantly, securing competitive advantage in a fast-moving world - requires NI to move rapidly to acquire the technologies and technology skills it needs.

This means attracting businesses and individuals with the right skill set to come to NI. It also means focussing on the strategically important technologies and pulling back from some which might dilute resource and perhaps have less contribution to make to NI's journey towards net zero.

Creative Industries are strong in this scenario because of their importance to attracting high value mobile workers.

The skills maps on the following pages indicate the breadth of skills that NI will require to thrive in this future. Matching these against the current baseline will indicate which skills NI needs to prioritise.

The strategy of attracting skills in removes the need to develop them directly and frees up local labour to build the service economy that NI will need to support these developments. Making these jobs attractive and valued will require more than competitive salaries - although these too will be essential - and will need to be driven by a cultural shift that celebrates service jobs as a fundamental piece of the platform for making NI one of the foremost locations in the world.

Prominent technologies in *Optional Workplaces*

Embedded IoT sensors and data analytics for real-time monitoring of energy usage, traffic patterns and other urban metrics, enabling better resource management

Construction and retrofitting of buildings to be highly energy efficient

Centralising energy production and distribution using smart grids and deploying heat pumps and waste heat from industrial processes

Establishing EV charging infrastructure and electrifying all public transportation

Designing pedestrian-friendly and bike-friendly infrastructure

Using sustainable and locally sourced building materials with low carbon footprint

Data driven decision making using data analytics to improve service design, target policy interventions and focus resource allocation

IOT and data analytics for real time monitoring and management of (for example) transportation, energy use and waste management

Digital delivery of public services such as tax filing, voter registration, social welfare applications. Collection of citizen data enables personalised service delivery

Digital identity authentication to provide secure digital identity systems

Omics to understand disease mechanisms and deliver personalised treatments

Remote patient monitoring through wearable devices and telehealth platforms

Data Integration of, for example, electronic health records, genomics data and wearables to design personalised treatments and disease prevention strategies

Data collection on soil and crop conditions to optimise planting, irrigation, fertilisation and pest management

Vertical Farming, growing crops in stacked layers indoors using controlled environments

Commentary

Advanced Manufacturing and Engineering is the most prominent cluster due to the extensive redevelopment of NI's urban centres. Engineering skills are in demand - but advanced manufacturing skills are not. Like other technologies, it is concentrated in the global research effort.

The deployment of ICT is focused on the application and maintenance of systems rather than on their development, which reduces the importance of other skills in the Digital, ICT and Creative Industries clusters. The same is true in Life and Health Sciences.

Agriculture is important, of course, but the skills base is reduced. Here, too, it is the application of technology that is key to success.

One strategic consequence of this scenario is that NI will - at some point in the late 2030s or early 2040s - have access to the technologies that are being developed at the global level. Applying those technologies to mitigate the impacts of climate change and to help NI adapt to its consequences will require skills that NI will likely have reduced investment in. NI will therefore need a strategic approach to rapid skills development or, perhaps - as in *Net Zero Workplaces* - to buying in the right skills at the right time. In this scenario, such skilled workers will be appointed to public delivery bodies or directly to the private sector. They will not be freelance workers.

Prominent technologies in *Shuttered Workplaces*

Secure networks and data encryption to transmit classified information and data that are resilient against cyberattacks and unauthorised access

Advanced Sensors, including radar and surveillance, to build comprehensive digital mapping and real time monitoring of the operational environment

Autonomous Systems to support unmanned drones, ground vehicles and naval vessels - remote surveillance, reconnaissance and data collection

Predictive Maintenance, using AI to monitor equipment and machinery remotely and to carry out remote repairs and maintenance in advance of need

Cybersecurity, detecting unusual patterns in network traffic, flagging security breaches and initiating automated protective countermeasures

Predictive Modelling of crime and criminal behaviours

Integrating robotics, cobotics and predictive analytics into supply chain management to reduce lead times, increase efficiency, and improve overall logistics processes

3D printing and rapid manufacturing to secure supply chains through localised prototyping, production and customisation

Cybersecurity including firewalls, intrusion detection/prevention systems and encryption technologies to safeguard sensitive data.

Applying biometrics to enhance security of cryptocurrency wallets and exchanges

Applying effective encryption to protect customer information and financial data from unauthorised access

Deploying intelligent agriculture solutions by applying sensors/data analytics/ internet of things technologies across all stages of the food chain

Commentary

This scenario demands resilience, inventiveness and a dogged approach to continuous improvement. There are no opportunities to rest on laurels for economies that seek to be successful.

Tech development is largely driven by niche activities in the defence and security sectors and by the private sector's need to shorten supply chains and control supply.

NI will be more successful if it collaborates across multinational supply chains. Markets are likely to dry up quickly if it does not. Establishing clear blue water strategies - but being willing to adapt and flex quickly - will be key.

Adaptability will be an entry level requirement for business and for individuals - and the pressure to adapt continuously will be stronger in this scenario than in others.

Of all the scenarios, then, this one perhaps demands the greatest cultural shift in NI's business base. And, perhaps, failing to achieve that cultural shift is a greater threat to future prosperity in NI than in any other scenario.

8. The report draws **six broad conclusions** from the analysis of future skills requirements and the scenario modelling:

- Core skills in technology sectors are changing constantly
- Socio-emotional skills are key to future strategic adaptability
- The Digital, ICT and Creative Industries cluster is in the top two most important clusters in all scenarios
- Other clusters vary in importance across different scenarios and NI therefore needs to strengthen its strategic foresight capability to anticipate change
- NI's technology focus may be too broad and may need to be narrowed
- Government and business may need to work more closely with FE and HE to shape the future technology skills pipeline

9. The scenarios highlight **key strategic risks to delivering Innovation, Inclusion and Sustainability** over the next decade. Policy makers can use the scenarios to explore these risks further and, by doing so, can identify where they might need to adapt policy to achieve NI's economic ambitions.

10. Analysis of how easy - or challenging - it will be to achieve Innovation, Inclusion and Sustainability across the scenarios highlights that

- The conditions for achieving Innovation, Inclusion and Sustainability are ***only favourable*** for NI in one scenario: *Net Zero Workplaces*.

This does not mean Innovation, Inclusion and Sustainability will be achieved in *Net Zero Workplaces* - government and its partners will still need to implement policies for delivering them - but that the task will be easier.

- The conditions for achieving Innovation and Inclusion are ***relatively favourable*** in *Autonomous Workplaces* - but the scenario suggests that, to be effective, policy interventions will need to be different to those in *Net Zero Workplaces*. In particular, policy makers may need to develop more focussed interventions to boost innovation startups and to strengthen innovation in the existing business base.

They may also need to focus considerable effort on closing the gap between the richest and poorest in society; although this will be challenging in this scenario where average income will be lower than in *Net Zero Workplaces*.

• Sustainability ***will not*** be achieved in *Autonomous Workplaces* without significant changes to government policy that prioritise the pursuit of net zero over economic growth. This will be challenging due to the potential consequences for society and, if the policy environment that is in place in the UK in 2023 remains, the lower priority placed on net zero by the UK government.

• *Shuttered Workplaces* is a deeply challenging scenario for NI. Innovation, Inclusion and Sustainability are all unachievable under these scenario conditions. Failure is, perhaps, a cultural issue as much as an economic one.

• *Optional Workplaces* is a fairly challenging scenario for NI. Some progress is made towards delivering Sustainability but Innovation and Inclusion are at risk, primarily because of limited technology opportunities. Despite these outcomes, Optional Workplaces is a fairly positive scenario from a societal perspective.

11. Policy makers can use the scenarios to determine

Whether the current direction of travel is favourable for NI and, in particular, for delivering Innovation, Inclusion and Sustainability

• What future vulnerabilities and risks the NI economy might face in the policy areas

• What NI can do now to ameliorate future challenges and to capture future opportunities

• What global trends NI needs to track to determine the future conditions for delivering its economic ambitions

• What future developments will trigger further policy interventions to optimise the chances of success

1. Introduction

In October 2020, Matrix commissioned Firetail to conduct a futures study on the Technology and High Technology Skills and Workforce needs Northern Ireland might face in the decade to 2035.

The specific aims of the study were to

- Develop a set of scenarios that explore alternative ways the world might develop and how technology and access to skills might shape future regional competitiveness
- Use the scenarios to test Northern Ireland's technology and science capabilities and determine areas of excellence where it has competitive edge and resilience
- Provide detailed futures analysis of these areas of excellence through a horizon scanning programme to provide rich intelligence about their development over the decade and identify key opportunities for Northern Ireland to pursue
- Identify the future skills, training and education that Northern Ireland will require to capitalise on these opportunities
- Set out recommendations for policy development and practical policy interventions that will deliver NI's futures skills, training and educational requirement

This report, completed by Waverley Consulting, offers a refresh of Firetail's study and takes account of DfE's *Skills Strategy*.

The aims of the original study still stand, but this analysis therefore adds one more:

- Examine the challenges and opportunities for achieving Innovation, Inclusion and Sustainability across the scenarios and highlight the implications for policy.

Scenario planning is a process that helps policy makers explore alternative ways that factors such as technology might shape the economy and workforce in the future. The scenario process helps them think about the different choices and routes to success they might face.

It does so by identifying what's driving change and building a set of stories that offer alternative views of what the future might look like and the different challenges and choices that governments, businesses and citizens might face in each.

The underlying principle of scenario thinking is uncertainty. The purpose of the scenario process is to identify the critical strategic uncertainties for the future and to gather different thoughts and perspectives on their causes and possible outcomes. The scenario narratives are stories that explore what these outcomes might be and what they might mean for different stakeholders and the choices they might face.

Scenarios are not predictions. Some parts of the narrative may happen in the future and some may not; some actors may choose to behave in ways the scenarios depict, others may not. The only aspect of the scenarios that is certain is that the future will not look like any one of them – it will be a combination of some of the elements they describe and other elements that have not yet been thought about.

The scenarios are not, therefore, meant to be 'right', but to offer interesting (and in some cases challenging, stretching or controversial) pictures of the future. They provide a space – a sandbox - where leaders can explore the dynamics of change and can rehearse the policy choices and decisions they are likely to face on the path to success.

This report is divided into 7 sections:

- Section 1 introduces the report
- Section 2 sets out the strategic context for Northern Ireland
- Section 3 presents our analysis of the skills that will be required in each of the innovation intense sectors.
- Section 4 describes how the scenarios were developed by Firetail and how they have been adjusted in this report
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This document is interactive - it can be navigated from page to page as normal or by clicking on the right facing triangles in the right margin to move forward one page and clicking on the left facing arrow in the left margin to move back one page. Each section title page contains these arrows in the footer beside the page numbers.

Section headings are shown in the menu at the top of the page and the current section is highlighted in blue. Subheadings for each section are set out below the line; the current subheading is highlighted in blue.

The menu at the top of the page is interactive. Clicking on any section heading - or any subheading within a section - will take the reader directly to the relevant part of the document.

Given that this report is a refresh rather than a rewrite of the Firetail report, we have adapted the *main* content from original report. Some information - mainly that included in the Annexes of Firetail's report are not replicated here.

2. Strategic context

DfE's economic vision includes focussing on a number of R&D intensive sectors and associated technologies that NI hopes will drive economic success in the future.

The five priority clusters are:

- Digital, ICT and Creative Industries
- Fintech/Financial Services
- Life and Health Sciences
- Agritech
- Advanced Manufacturing and Engineering

DfE's Skills Strategy for Northern Ireland examines the supply of skills into the NI economy and sets three Strategic Goals to deliver higher growth in future:

- To increase the proportion of individuals leaving Northern Ireland higher education institutions with first degrees and post-graduate qualifications in narrow STEM subjects
- To increase the proportion of the working age population with qualifications at level 2 and above
- To increase the proportion of the working age population with qualifications at level 3 and above

The goals are not specifically linked to the innovation intense sectors or technologies but are about increasing the proportion of the population with skills at different levels.

While DfE's skills strategy is primarily focused on the mechanisms by which skill levels can be improved and individuals can access training and education, it recognises that the innovation intense sectors will need bespoke skills development plans.

It also notes that the core employability skills and range of higher level 'soft' skills - key for sustained economic success - are likely to change in future. In particular, it highlights the need to ensure that workers are better equipped to manage in an increasingly digital world.

The next section of this report - Skills for the future - takes a detailed look at the skills needs of the five clusters and their associated technologies over the next 10-15 years and explores what those changes to core skills might be. In doing so, the report offers insights into the most important, strategically underpinning skill sets that the Northern Ireland economy will need access to in order to achieve its ambition.

Our analysis is further informed by the wider strategic change and uncertainty the world faces in the next 10 years and beyond. We have paid particular attention to four significant forces that are in play and that will shape - and disrupt - the global business environment:

- The climate and nature crises are existential threats that are accelerating faster than anticipated. The creation of less damaging ways of doing business and the growth of new sectors and opportunities will demand specific skill sets within those sectors and throughout the economy
- Demographic changes will shift the balance between the productive and non-productive parts of the population. This may lead to labour shortages and the need to continually retrain an ageing workforce in emerging technologies
- Global shifts in economic and political power from west to east and north to south will change the landscape for trade, investment and influence. The markets for goods and services in Asia are huge and growing rapidly - dominating sectors and technology development. No longer just manufacturing hubs, Asian/Pacific economies are moving up the value chain in education, innovation and science.
- Digital and AI-powered technologies are transforming the world of work, pushing the managers and workers to learn new in-demand skills and adapt to future jobs. These technologies are becoming embedded faster than anticipated.

Technology, in general, will play a huge role in the world's collective response to these challenges. In order to be a lead actor - and to prepare for and navigate through the economic disruption these forces will create - Northern Ireland needs to invest in developing and deploying the strategic skills it will require for future success throughout the economy.

There is, we suggest, no time to lose.

These strategic skills will need to be available at all levels and in all sectors. Recruitment criteria will increasingly be based on skill sets and transferability, rather than on specific job related skills. Businesses will need to take a proactive approach to upskilling and reskilling their workforce if they want to be fit for the future.

Businesses will, moreover, need to be strategically literate, constantly assessing the changes in the global market and adapting quickly in order to sustain competitive advantage.

3. Skills for the future

This section of the report reviews the skills needs of innovation intense sectors and their associated technologies over the next 10-15 years. In doing so, it provides insights into the most important and shared skill sets that regions will require if they wish to be competitive in the future.

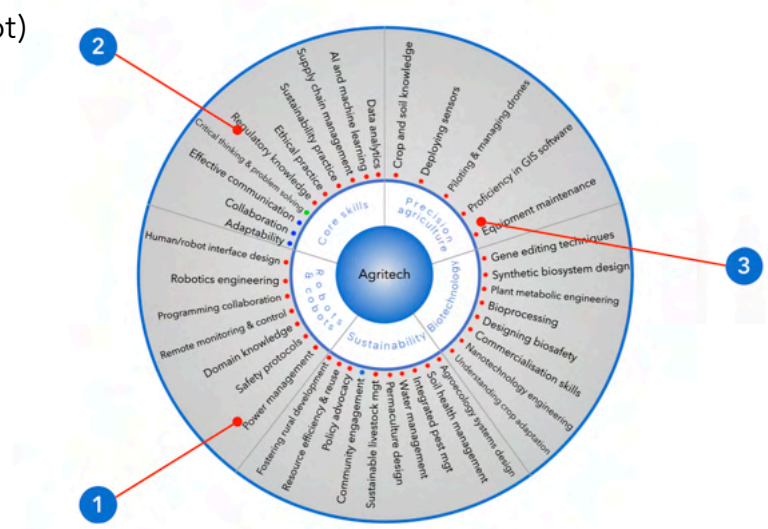
The report utilises the World Bank's typology of skills required for future success:

- Foundational and higher order skills, which are specialised skills that encompass the ability to understand complex ideas, adapt effectively to the environment, learn from experience, and reason.
- Socio-emotional skills, which describe the ability to manage relationships, emotions, and attitudes. These skills include being able to navigate interpersonal and social situations effectively, as well as leadership, teamwork, self-control, and determination.
- Specialised skills, which refer to the acquired knowledge, expertise, and interactions needed to perform a specific task, including the mastery of required materials, tools, or technologies.

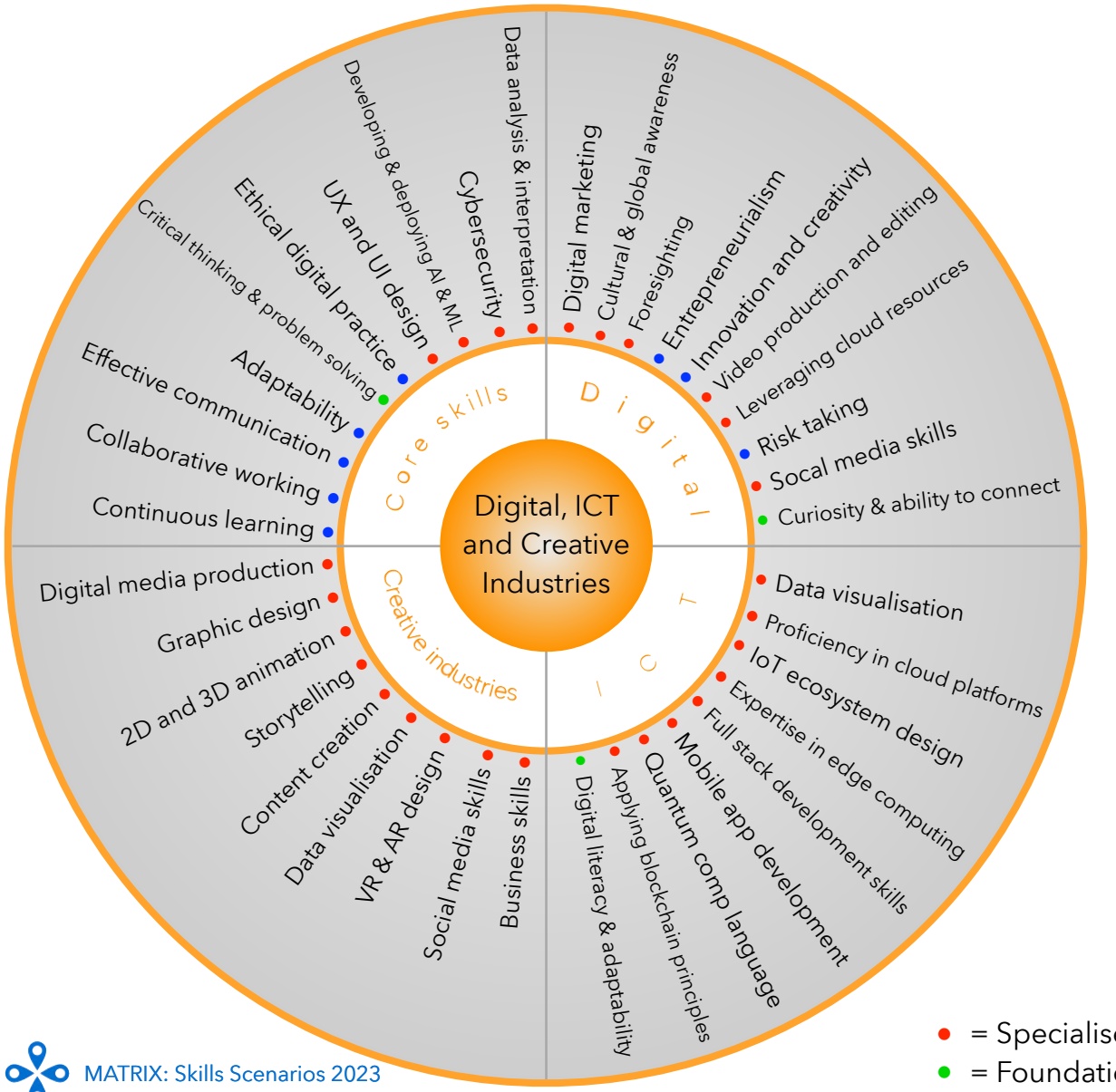
The future skills required by each cluster are set out schematically in a sector skills wheel (see, for example, the Agritech wheel on the right).

Each wheel

1. Lists the skills that will be required for future success, grouped by individual technology or practice area
2. Identifies a set of core skills that will be required across the sector
3. Categorises each skill according to whether they are Specialised skills (colour coded with a red dot), Foundational and higher order skills (a green dot) or Socio-emotional skills/personal attributes (a blue dot)



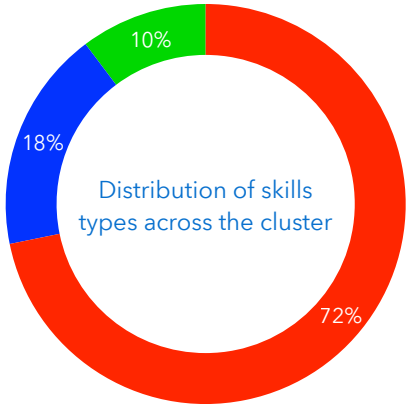
The pages that follow each wheel contain a description of the skills in each technology or practice area. The final section of this chapter provides a commentary on these findings. Section 6 of the report provides a more detailed analysis of the strategic implications for NI.



The skills required for future success in the Digital, ICT and Creative Industries priority cluster fall into four categories:

- Digital
- ICT
- Creative industries
- 'Core skills' - that is, skills which are required in all 3 sectors in the cluster (Digital, ICT and Creative Industries)

There are 10 core skills of which 4 are specialised skills, 1 is a foundational and higher order skill and 4 are socio-emotional skills.



- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills

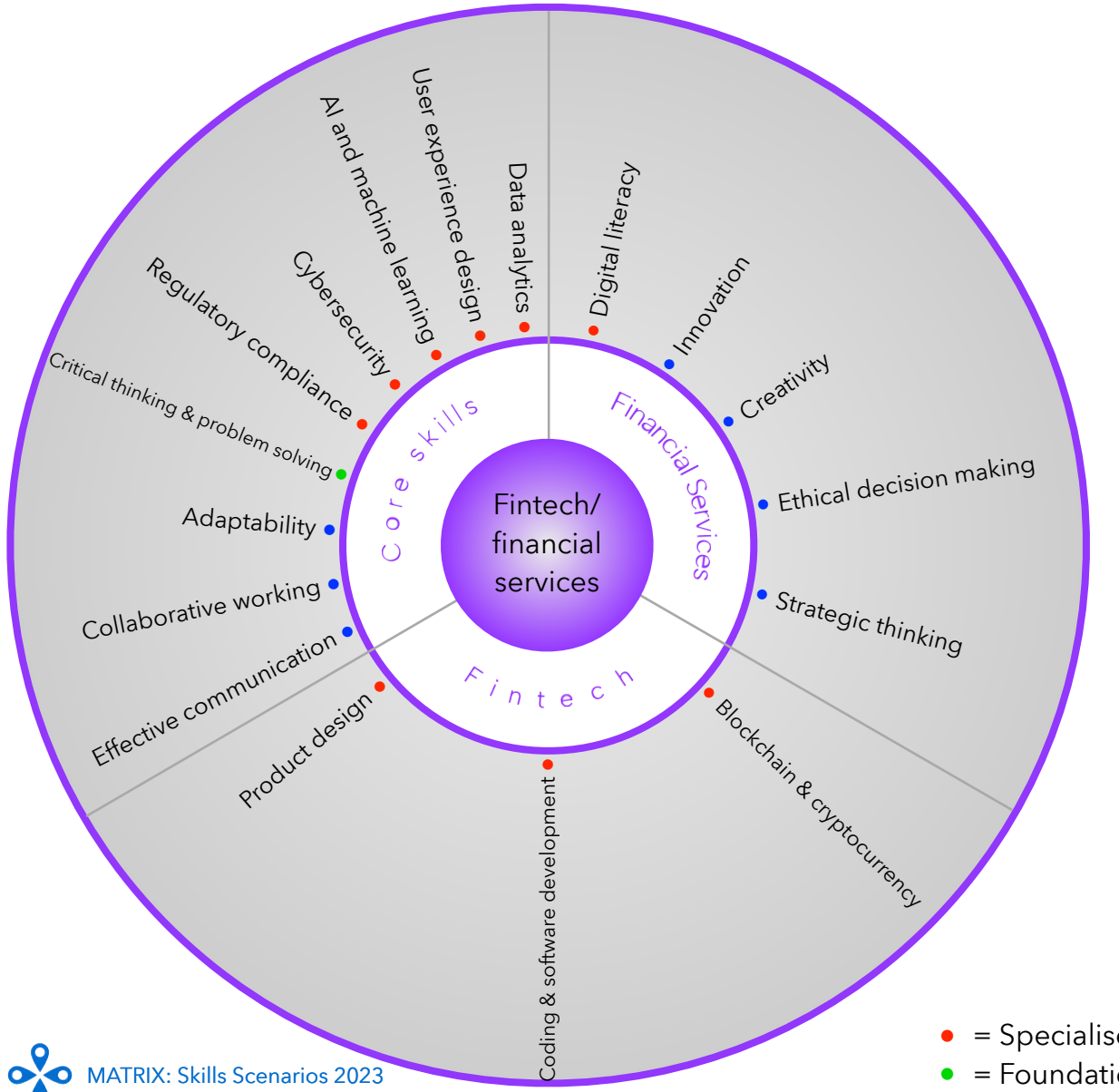
Core Skills		
Skill	**Type**	**Description**
Data analysis and interpretation	Specialised	The ability to collect, analyse, and draw insights from data is crucial. Skills in data visualisation, statistical analysis, and understanding data trends can drive informed decision-making.
Developing and deploying AI and MI	Specialised	As AI and machine learning continue to advance, skills related to developing, implementing, and managing AI-driven solutions will be crucial. This includes understanding neural networks, natural language processing, computer vision, and ethical considerations surrounding AI.
User experience (UX) & User interface (UI) design	Specialised	Creating seamless and user-friendly digital experiences is essential. UX/UI skills facilitate design of intuitive interfaces that cater to user needs and preferences.
Cybersecurity	Specialised	Skills related to securing networks, systems, and data, as well as expertise in ethical hacking, risk assessment, and compliance will be essential.
Ethical digital practice	Socio-emotional	Ethical digital practices - responsible and considerate behaviours when using technology and participating in the digital world – will become increasingly essential for building trust, operating ethically and creating positive online experiences.
Adaptability	Socio-emotional	Given the rapid pace of technological change, the ability to learn new skills quickly and adapt to new tools and technologies will be a fundamental skill.
Critical thinking and problem-solving	Foundational and higher order	Critical thinking skills enable individuals to analyse, evaluate, and synthesise information to make reasoned judgments and decisions. These skills are crucial for effective problem-solving, decision-making, and understanding complex issues.
Effective communication	Socio-emotional	Workers will need expertise with remote communication tools and project management software.
Collaborative working	Socio-emotional	The rise of remote work and distributed teams means that skills in effectively collaborating and managing projects digitally will be crucial.
Continuous learning	Socio-emotional	The rapid pace of technological change means the ability to learn new skills quickly and adapt to new tools and technologies will be a fundamental skill.

Digital		
Skill	**Type**	**Description**
Digital marketing	Specialised	Applying the principles of digital marketing, including social media, content creation, search engine optimisation (SEO), and online advertising. These skills are vital for promoting products, services, or ideas in the digital space.
Cultural and global awareness	Specialised	Understanding different cultures and global trends can help navigate diverse audiences and markets and inform design of applications in different markets.
Foresighting	Specialised	Applying research principles to spot and understand the future commercial, strategic or policy outcomes of emerging trends.
Entrepreneurialism	Socio-emotional	Judging when – and being willing - to take calculated risks, identify opportunities, and innovate in the digital space.
User centred design	Socio-emotional	User-centred designers need strong problem-solving skills to identify design challenges and find innovative solutions that meet user needs and business goals.
Video, production and editing	Specialised	Skills to integrate graphics, animations, and other multimedia elements seamlessly into video content will enhance the overall production quality. The ability to collaborate with team members and clients remotely is increasingly important.
Leveraging cloud resources	Specialised	Skills related to the use of current and next generation cloud platforms such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud will be key. Knowledge of cloud architecture, migration, and security will be essential.
Risk taking	Socio-emotional	Growth through innovation in digital design and exploiting new markets requires the ability to take risks. Willingness to explore new technologies, approaches, and opportunities – which might involve uncertain outcomes or potential challenges – is an essential skill.
Social media skills	Specialised	Social media is evolving rapidly and constantly. Future developments are likely to include more immersive experiences, delivery of highly personalised content and a greater understanding of how to create new types of online communities.
Curiosity and ability to connect	Foundational and higher order	Curiosity involves a strong desire to learn, explore, and understand new concepts, ideas, and technologies. This skill is particularly valuable in the digital age due to the rapid pace of technological advancements and the constant influx of information. The ability to network and connect ideas together in novel ways will be essential to create new forms of value.

ICT

Skill	Type	Description
Data visualisation	Specialised	With vast amounts of data being generated, the ability to create meaningful and visually engaging data visualisations will be crucial for conveying complex information effectively.
Proficiency in cloud platforms	Specialised	Proficiency in cloud platforms, such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud, will be important for designing and deploying scalable and efficient solutions.
IoT ecosystem design	Specialised	Design skills applied to IoT devices and systems that connect physical objects to the digital world will be widely needed.
Expertise in edge computing	Specialised	Edge computing is a rapidly evolving field, and the specific skills in demand may vary based on the applications and industries involved. Developing skills in edge computing is becoming increasingly important as more devices and applications require real-time processing and reduced latency.
Full stack development skills	Specialised	Skills in both front-end and back-end development, enabling developers to work on the entire stack of technologies required to build web applications, will be essential. These skills range from proficiency in creating well-structured, semantically correct HTML markup and styling with Cascading Style Sheets to proficiency in back-end languages such as Node.js, Python, Ruby, Java, or PHP.
Mobile app development	Specialised	Mobile app developers will require skills in programming languages and app development platforms for both iOS and Android apps. Skills in design and use of Application Integration Tools and mobile app security will be key.
Quantum computing language	Specialised	Skills related to quantum computing principles and programming languages will become increasingly relevant for tackling complex computational problems.
Applying Blockchain principles	Specialised	Proficiency in blockchain, distributed ledger technology, and cryptocurrency ecosystems will be important for applications in finance, supply chain, and beyond.
Digital literacy and adaptability	Foundational and higher order	A solid understanding of digital tools, platforms, and technologies. It encompasses basic computer skills, internet navigation, and using software applications effectively.

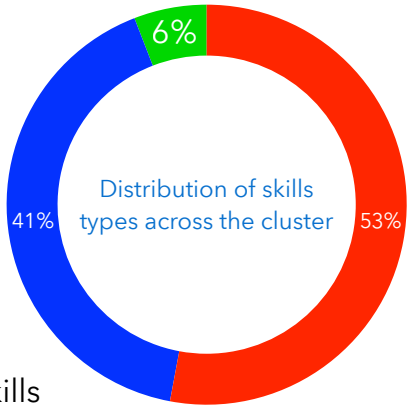
Creative Industries		
Skill	**Type**	**Description**
Digital media production	Specialised	Effective communication skills are as important as digital skills. Knowledge of the principles and practices of media production need to be combined with the ability to produce and direct scenarios and presentations for television, websites and film. Continuously updating knowledge of the operation, maintenance and repair of production equipment will be essential.
Graphic design	Specialised	Graphic design skills - how to effectively use typography in digital layouts, mastery of colour theory, knowing how to arrange elements on a digital canvas in a balanced and visually pleasing way, knowledge of branding principles, for example – will remain important.
2-D and 3-D animation	Specialised	The ability to draw well and express ideas visually will remain key. Proficiency in using 2D animation software (Photoshop, Adobe Animate, Toon Boom Harmony, and so on) will be necessary. 3D modelling software (e.g., Blender, Autodesk Maya) allows animators to create three-dimensional digital assets for various applications, from animation to product design.
Storytelling	Specialised	Storytelling remains a fundamental skill across various creative industries. Being able to craft compelling narratives that resonate with audiences will continue to be highly valued.
Content creation	Specialised	Knowledge of how to create personalised and immersive content that matches individual preferences to virtual events that offer new ways for audiences to engage with performers and artists.
Data visualisation	Specialised	The ability to create visually engaging and informative data visualisations can help communicate complex information effectively in digital formats.
VR & AR design	Specialised	As VR and AR become more prevalent, design skills in creating immersive experiences in gaming, storytelling, or design, will be in high demand.
Social media skills	Specialised	Effective management and curating content for social media platforms, along with knowledge of analytics tools, will be essential skills for engaging and growing digital audiences.
Business skills	Specialised	Having an entrepreneurial mindset – being innovative, proactive, and willing to take calculated risks – will be prized attributes. Strong leadership and effective networking and relationship building skills will support effective performance.



The skills required for future success in the Fintech/Financial Services cluster fall into three categories

- Fintech
- Financial services
- 'Core skills' - that is, skills which are required in both sectors in the cluster(Fintech, Financial Services)

There are 9 core skills: 5 are specialised skills, 1 is foundational and higher order and 3 are socio-emotional skills.

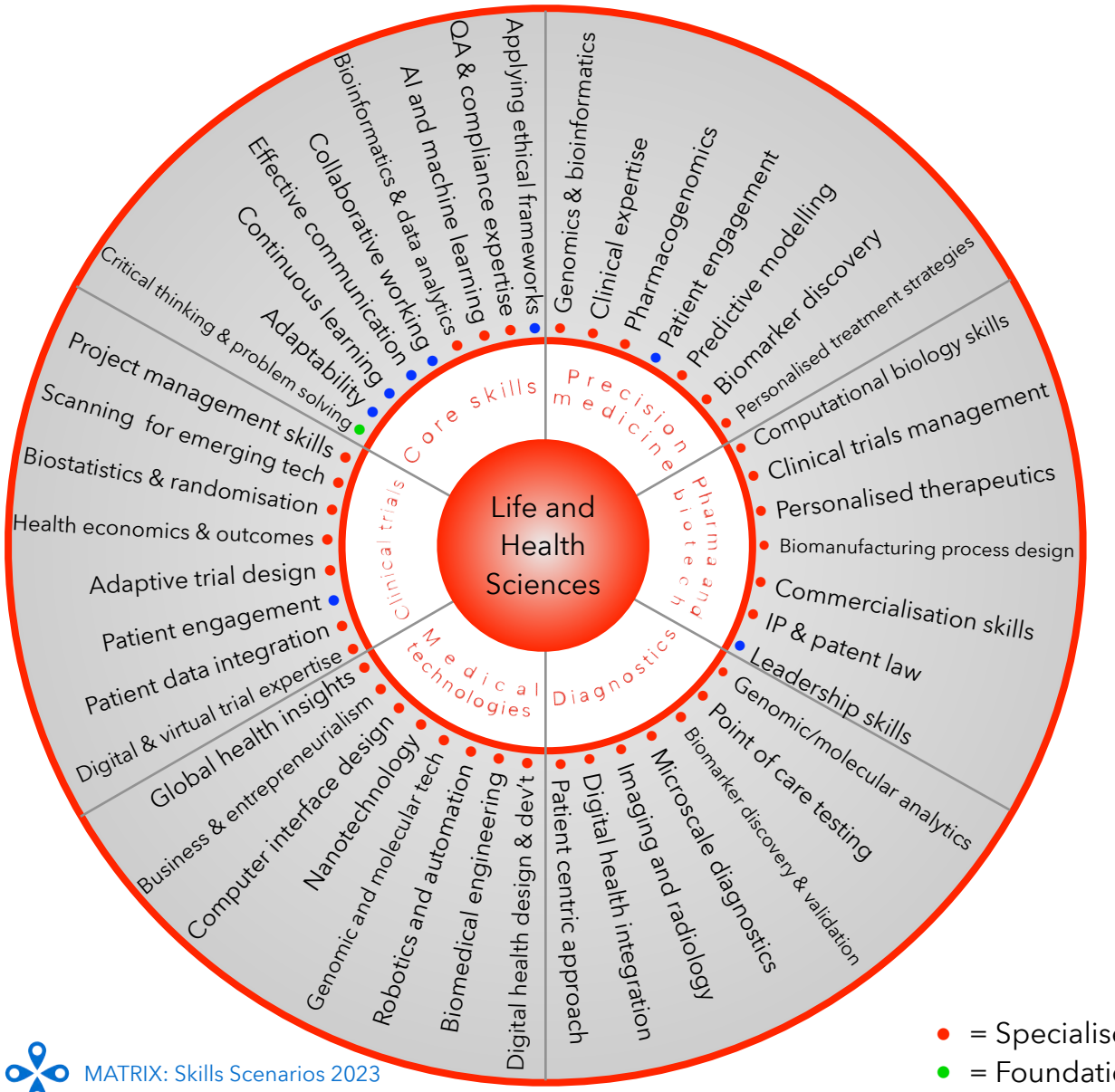


- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills

Core Skills		
Skill	**Type**	**Description**
Data analytics	Specialised	Fintech relies heavily on data-driven decision-making. Professionals need skills in collecting, analysing, and interpreting large volumes of financial data to identify trends, patterns, and insights that can drive business strategies and product development.
User experience design	Specialised	Fintech products need to provide exceptional user experiences to attract and retain customers. Professionals who can apply design thinking principles to create intuitive and user-friendly interfaces will have a competitive edge.
AI and Machine Learning	Specialised	Understanding machine learning algorithms, artificial intelligence, and their applications in areas like fraud detection, credit scoring, algorithmic trading, and customer service automation is crucial. Proficiency in developing and implementing AI models will create significant advantage.
Cybersecurity	Specialised	The increasing reliance on digital platforms and online transactions means cybersecurity is a top priority. Fintech professionals need to understand how to protect sensitive financial data and develop strategies to mitigate potential risks.
Regulatory compliance	Specialised	Fintech operates in a highly regulated environment. Staying updated on the latest financial regulations, compliance requirements, and understanding how they impact fintech operations is essential to avoid legal and financial pitfalls.
Critical thinking and problem-solving	Foundational and higher order	Critical thinking skills enable individuals to analyse, evaluate, and synthesise information to make reasoned judgments and decisions. These skills are crucial for effective problem-solving, decision-making, and understanding complex issues.
Adaptability	Socio-emotional	The fintech landscape will continue to evolve rapidly. Professionals need to be adaptable and committed to continuous learning to keep up with new technologies, market trends, and industry best practices.
Interdisciplinary collaboration	Socio-emotional	Fintech is a multidisciplinary field that requires collaboration between business, technology, legal, and regulatory teams. Strong communication and collaboration skills are essential for effective teamwork.
Effective communication	Socio-emotional	Effective communication is key when explaining complex financial concepts to clients, colleagues, and stakeholders. Clear communication fosters trust and ensures everyone is on the same page.

Financial services		
Skill	**Type**	**Description**
Digital literacy	Specialised	Fintech professionals will need to be skilled in digital tools, platforms and technologies. They will need foundational skills in digital communication, online collaboration and using bespoke software applications.
Innovation	Socio-emotional	The financial industry is evolving rapidly. Professionals will need to innovate constantly and explore new ways to provide value to clients in order to create competitive advantage.
Creativity	Socio-emotional	The ability to create new approaches and ideas through creative thinking – being open to different approaches, exploring and adapting ideas from other disciplines and applying flexible thinking to problem solving, for example – will be a prized skill.
Ethical decision making	Socio-emotional	Financial professionals need to make ethically sound decisions, especially when dealing with clients' finances. An understanding of ethical considerations and the ability to navigate complex ethical dilemmas is important.
Strategic thinking	Socio-emotional	Understanding the broader business landscape, identifying emerging opportunities, and formulating strategic plans are crucial skills for long-term success in financial services.

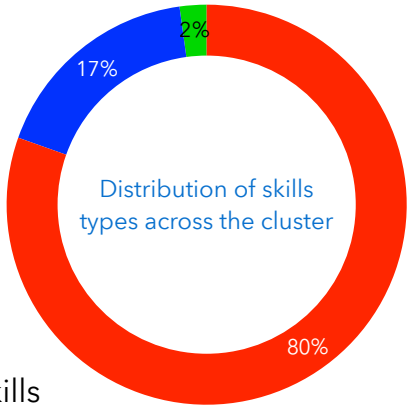
Fintech		
Skill	**Type**	**Description**
Blockchain and cryptocurrencies	Specialised	Fintech has strong ties to blockchain technology and cryptocurrencies like Bitcoin and Ethereum. Knowledge of how blockchain works, its potential applications, and the regulatory environment surrounding cryptocurrencies is important.
Coding and software development	Specialised	Having a basic understanding of – and skill in - coding languages and software development processes will help fintech professionals communicate effectively with technical teams and contribute to product development.
Product design	Specialised	Designing financial services products requires a unique blend of financial expertise, user-centred design and strategic thinking.



The skills required for future success in the Life and Health Sciences cluster fall into six categories

- Precision medicine
- Pharma and biotech
- Diagnostics
- Medical technologies
- Clinical trials
- 'Core skills' - that is, skills which are required in all 5 sectors in the cluster (Precision medicine, Pharma and biotech, Diagnostics, Medical technologies, Clinical trials)

There are 9 core skills: 3 are specialised skills, 1 is a foundational and higher order skill and 4 are socio-emotional skills.



- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills

Core Skills		
Skill	**Type**	**Description**
Applying ethical frameworks	Socio-emotional	A strong grasp of ethical considerations and regulatory requirements surrounding all aspects of life and health sciences – and the skills to apply them effectively to practice - will be essential. So, will the design and application of ethical frameworks and – crucially – the skills to update them on a regular basis in a fast-moving environment.
QA and compliance expertise	Specialised	Expertise in ensuring quality control and compliance with regulatory standards, including monitoring, auditing, and inspection processes.
AI and machine learning	Specialised	Integrating artificial intelligence and machine learning algorithms into all aspects of life and health science workflows will improve diagnostic accuracy and improve outcomes. Professionals who are skilled in customising and applying these tools for pattern recognition and predictive modelling will be in high demand.
Bioinformatics and data analytics	Specialised	As research and practice develops large amounts of complex data, skills in bioinformatics and data analysis are essential for interpreting genomic, proteomic and metabolic information and extracting clinically relevant insights.
Collaboration	Socio-emotional	Collaboration between researchers, developers, clinicians, bioinformaticians, engineers, and other experts is essential for developing comprehensive diagnostic solutions. Strong interpersonal and communication skills are crucial for effective teamwork.
Effective communication	Socio-emotional	Effective communication is key when explaining complex financial concepts to clients, colleagues, and stakeholders. Clear communication fosters trust and ensures everyone is on the same page.
Continuous learning	Socio-emotional	Life and health sciences is a rapidly evolving field with new discoveries and technologies emerging regularly. Professionals must have a commitment to – and be skilled at - continuous learning to stay up to date with the latest advances.
Adaptability	Socio-emotional	Practitioners must also be skilled at adapting research processes and treatment strategies in light of new developments. Adapting at speed – and perhaps almost continuously – will be key for sustained competitive success in the future.
Critical thinking and problem-solving	Foundational and higher order	Critical thinking skills enable individuals to analyse, evaluate, and synthesise information to make reasoned judgments and decisions. These skills are crucial for effective problem-solving, decision-making, and understanding complex issues.

Precision medicine		
Skill	**Type**	**Description**
Genomics and bioinformatics	Specialised	As genomic data becomes more complex and abundant, proficiency in advanced sequencing technologies, data analysis and interpretation will be crucial. Bioinformatics skills will enable researchers and clinicians to extract meaningful insights from large-scale genomic datasets.
Clinical expertise	Specialised	A solid foundation in clinical medicine is essential to translate genomic findings into actionable treatment plans. Professionals should be skilled in disease pathology, treatment options, and patient care to make informed decisions.
Pharmacogenetics	Specialised	Knowledge of how genetic variations affect drug response will become increasingly important. Pharmacogenomic skills enable the customisation of drug treatments based on an individual's genetic makeup.
Patient engagement	Socio-emotional	Professionals need skills to educate and engage patients about the benefits and risks of precision medicine, ensuring patients are informed and actively participate in their healthcare decisions.
Predictive modelling	Specialised	The ability to develop predictive models that forecast disease risks, treatment outcomes, and disease progression based on patient-specific data will be crucial for guiding clinical decisions.
Biomarker discovery	Specialised	Identifying novel biomarkers associated with diseases and treatment response requires skills in experimental techniques, data analysis, and validation methods.
Personalised treatment strategies	Specialised	Professionals should have the skills to develop personalised treatment plans that incorporate genomic and clinical information, balancing efficacy, safety, and patient preferences.

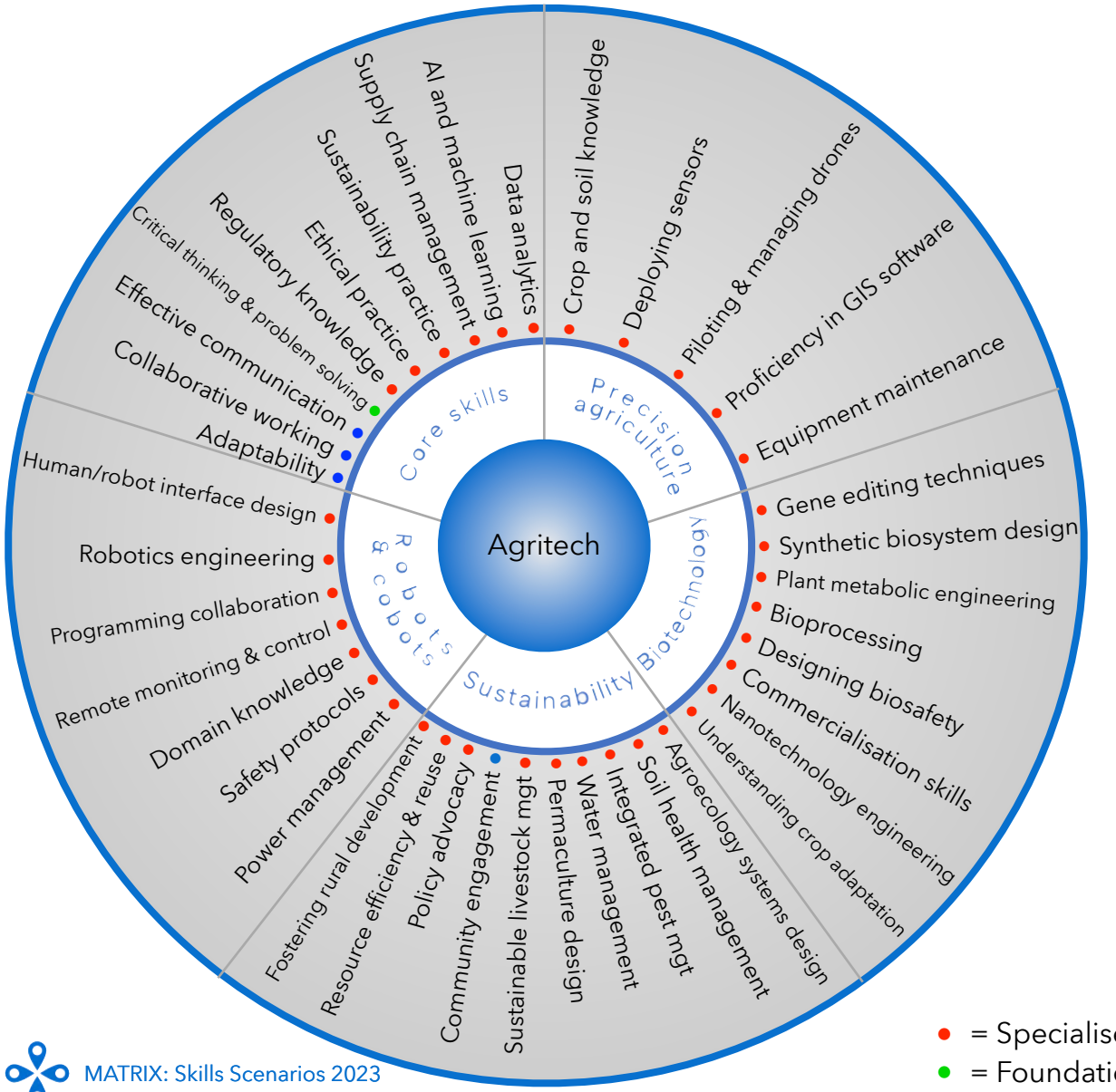
Pharma and biotech		
Skill	**Type**	**Description**
Computational biology	Specialised	As the field of genomics and molecular biology continues to expand, professionals will need to be skilled at using computational tools to analyse biological data, model biological processes and predict drug interactions.
Clinical trials management	Specialised	Expertise in designing and managing clinical trials, including knowledge of patient recruitment, data collection and regulatory submissions, will continue to be essential for bringing new treatments to market.
Personalised therapeutics	Specialised	Proficiency in developing and implementing personalised treatment approaches, based on a consideration of patients' genetic, molecular and clinical profiles, will play a significant role in shaping the future of healthcare.
Biomanufacturing process design	Specialised	As therapies become more complex and biologics gain prominence, professionals who can design and optimise biomanufacturing processes will be crucial to ensure efficient and cost-effective production.
Commercialisation	Specialised	Understanding market dynamics, payer perspectives and healthcare economics will be essential for successfully launching and commercialising new drugs and therapies.
IP and patent law skills	Specialised	Science professionals who understand intellectual property laws and are skilled at navigating the patent landscape will be needed to support protection of (and maximising the value of) innovative products.
Leadership skills	Socio-emotional	As the life and health sciences sector grows and becomes more complex, effective leadership and management skills will be crucial for guiding teams, making effective strategic decision and driving organisational changes to deliver success.

Diagnostics		
Skill	**Type**	**Description**
Genomics/molecular analytics	Specialised	Proficiency in techniques such as next-generation sequencing (NGS), polymerase chain reaction (PCR) and other molecular methods will remain crucial for analysing genetic and molecular markers associated with diseases.
Point of care testing	Specialised	A growing emphasis on rapid and decentralised testing will mean that skills in developing and using portable, user-friendly diagnostic devices for use at the point of care will be key.
Biomarker discovery and validation	Specialised	Proficiency in identifying, validating, and characterising biomarkers associated with diseases will play a critical role in improving early detection and monitoring of conditions.
Microscale diagnostics	Specialised	Knowledge of microscale devices for performing complex diagnostic assays will be important for miniaturising and automating laboratory processes.
Imaging and radiology	Specialised	Expertise in medical imaging technologies, such as MRI, CT scans, and molecular imaging, will remain crucial for visualising and diagnosing diseases.
Digital health integration	Specialised	As diagnostics become increasingly integrated with digital health platforms, professionals who are skilled in developing and managing connected diagnostics solutions and who can integrate data into electronic health records will be in demand.
Patient centric approaches	Specialised	Professionals who can effectively communicate diagnostic results to patients and help them understand the implications of their test outcomes will play a key role in improving patient care and outcomes.

Medical technologies		
Skill	**Type**	**Description**
Global health insights	Specialised	Knowledge of healthcare systems and needs in different regions and cultures will guide the development of impactful and inclusive medical technologies.
Business and entrepreneurialism	Specialised	Understanding the commercialisation process, market dynamics and business models and applying the principles to bring innovative medical technologies to market will be important.
Computer interface design	Specialised	Expertise in designing user-friendly and intuitive interfaces for medical devices and software will be required for efficient and effective interactions between healthcare professionals and technology.
Nanotechnology	Specialised	Skills in developing and applying nanoscale technologies for drug delivery, diagnostics and tissue engineering will drive innovations in medical treatments.
Genomic and molecular technology	Specialised	Understanding and applying genomic sequencing, gene editing, and molecular diagnostics will be crucial in advancing personalised medicine and precision therapies.
Robotics and automation	Specialised	Proficiency in designing and operating robotic systems for surgical procedures, rehabilitation and other medical applications will become increasingly important.
Biomedical engineering	Specialised	Knowledge of designing and developing medical devices from concept to prototyping and manufacturing will be essential for creating innovative healthcare solutions.
Digital health design and development	Specialised	Proficiency in designing, developing, and implementing digital health solutions, including telemedicine platforms, wearable devices, and remote patient monitoring tools, will be crucial.

Clinical trials

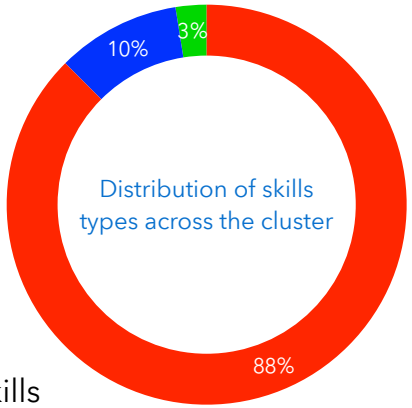
Skill	Type	Description
Project management skills	Specialised	Strong project management skills to coordinate and oversee various aspects of trial planning, execution, and reporting within time and budget constraints.
Scanning for emerging technologies	Specialised	Knowing how to find and evaluate the importance of emerging technologies such as blockchain for data security, artificial intelligence for patient recruitment and data sharing platforms for collaborative research will be key.
Biostatics and randomisation	Specialised	Skills in biostatistics, randomisation, and blinding strategies to ensure robust and unbiased trial results.
Health economics and outcomes	Specialised	Knowledge of health economics and how to incorporate patient-reported outcomes, quality of life measures, and cost-effectiveness assessments into trial design.
Adaptive trial design	Specialised	Expertise in designing and conducting adaptive clinical trials that allow for modifications based on interim results, leading to more efficient and flexible trial processes.
Patient engagement	Socio-emotional	Proficiency in engaging and involving patients in trial design, recruitment, and participation to ensure patient needs and perspectives are considered.
Patient data integration	Specialised	Ability to integrate real-world data from electronic health records, claims databases and patient-generated data to supplement traditional trial data.
Digital and virtual trial expertise	Specialised	Proficiency in conducting decentralised or virtual clinical trials, utilising digital health technologies, telemedicine, wearable devices and remote patient monitoring.



The skills required for future success in the Agritech cluster fall into five categories

- Precision agriculture
- Biotechnology
- Sustainability
- Robots & cobots
- 'Core skills' - that is, skills which are required in all 4 sectors in the cluster (Precision agriculture, Biotechnology, Sustainability, Robots & cobots)

There are 10 core skills: 6 are specialised skills, 1 is a foundational and higher order skill and 3 are socio-emotional skills.



- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills

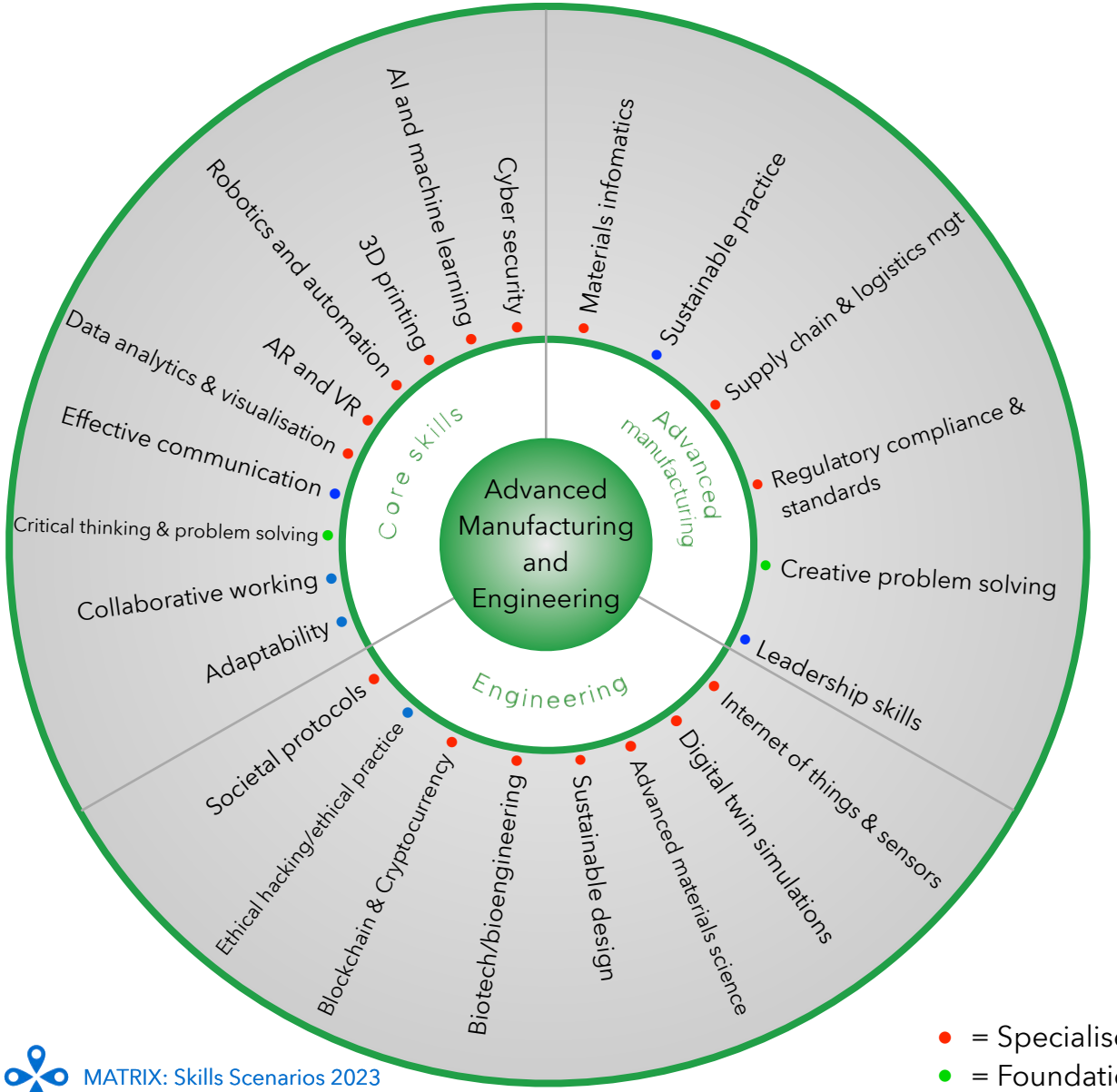
Core Skills		
Skill	**Type**	**Description**
Data analytics	Specialised	Data analytics skills - including collecting, processing, and interpreting agricultural data from various sources such as sensors, satellites and drones – will be key to making informed and competitive operational and strategic decisions.
AI and Machine learning	Specialised	Machine learning skills will be important for developing predictive models that optimise crop yields, resource usage and pest management.
Agricultural Supply Chain Management	Specialised	Understanding the agricultural supply chain, from production to distribution, will be important for optimising the delivery of agritech products and services to end-users.
Sustainability practice	Specialised	Expertise in implementing sustainable farming practices, organic farming, and regenerative agriculture techniques to reduce environmental impact.
Ethical practice	Specialised	Ethical considerations will play an increasingly crucial role in the development and application of agritech solutions. Agritech professionals will require detailed understand of ethical practice and be skilled in applying ethical principles to ensure innovation benefits society, the environment, and the agricultural sector as a whole.
Regulatory knowledge	Specialised	Knowledge of agricultural regulations, permits and compliance requirements - and how to meet them - will be crucial, especially when dealing with genetically modified organisms, pesticides and other regulated aspects of agriculture.
Critical thinking and problem-solving	Foundational and higher order	Critical thinking skills enable individuals to analyse, evaluate, and synthesise information to make reasoned judgments and decisions. These skills are crucial for effective problem-solving, decision-making, and understanding complex issues.
Effective communication	Socio-emotional	Effective communication is key when explaining complex financial concepts to clients, colleagues, and stakeholders. Clear communication fosters trust and ensures everyone is on the same page.
Collaboration	Socio-emotional	Effective communication skills will be necessary to convey complex technological concepts to farmers and stakeholders. Collaborative skills will be essential when working with multidisciplinary teams to develop and implement agritech solutions.
Adaptability	Socio-emotional	Agritech professionals will need to be adept at identifying emerging challenges and opportunities in the agriculture sector and developing innovative solutions in advance of need. The ability to adapt to evolving technologies and changing market conditions will be important.

Precision agriculture		
Skill	**Type**	**Description**
Crop and soil knowledge	Specialised	A deep understanding of crops, soil types, nutrient management, and agronomy is necessary to make informed decisions about planting, fertilisation, irrigation, and pest management. This knowledge helps tailor skilled interventions to specific crop and soil conditions.
Deploying sensors	Specialised	Precision agriculture involves using various sensors (e.g., moisture, temperature, nutrient sensors) to monitor crops in real-time. Knowing how to deploy, maintain, and interpret data from these sensors is crucial for timely interventions.
Piloting and managing drones	Specialised	Unmanned aerial vehicles (UAVs) or drones are used for aerial imaging, mapping, and monitoring crops. Piloting drones and processing the imagery they capture requires technical skills and understanding of flight regulations.
Proficiency in GIS Software	Specialised	Geographic Information Systems (GIS) and remote sensing technologies allows farmers to build detailed maps and analyse spatial patterns in the field. Proficiency in GIS software and interpreting remote sensing data enables is key to assessing variability within a field and making targeted management decisions.
Equipment maintenance	Specialised	Precision agriculture often involves the use of specialised machinery and equipment, such as GPS-guided tractors and automated irrigation systems. Proficiency in operating and maintaining this equipment is important for efficient operations.

Biotechnology		
Skill	**Type**	**Description**
Gene editing techniques	Specialised	Genome editing using CRISPR-Cas9 has revolutionised biotechnology. Future professionals should have a strong understanding of this technology and its application to gene editing in agriculture.
Synthetic Biosystems design	Specialised	Understanding and application of synthetic biology techniques can allow researchers to engineer novel metabolic pathways in plants for improved productivity, nutrient utilisation and stress tolerance.
Plant metabolic engineering	Specialised	A strong foundation in plant physiology and biochemistry is fundamental for understanding the biological processes underlying crop growth, development, and responses to various stressors.
Bioprocessing	Specialised	Skills in bioprocess engineering and fermentation will be important for scaling up the production of biopharmaceuticals, biofuels, and other bio-based products.
Designing biosafety	Specialised	Skills for assessing and managing risks associated with biotechnology research and applications, including biosecurity and biosafety protocols, will be important for preventing potential hazards.
Commercialisation	Specialised	Skills in bringing biotech innovations to the market, securing funding, navigating intellectual property laws and scaling up production will be important for those seeking commercialisation of new ideas.
Nanotechnology engineering	Specialised	Skills in designing and developing nanocarriers that can efficiently deliver nutrients, pesticides, and other agrochemicals to plants in a controlled manner will be important. Skilful design of nanoscale nutrient formulations will enhance nutrient uptake, improve fertiliser efficiency and reduce nutrient losses in the environment will also be key.
Understanding crop adaptation	Specialised	Developing crops that can thrive in changing climate conditions, such as extreme temperatures and altered precipitation patterns, will require skills in climate science and crop adaptation.

Sustainability		
Skill	**Type**	**Description**
Agroecology systems design	Specialised	Understanding the principles of agroecology involves considering the interactions between crops, animals, humans and the environment. Professionals will need to be skilled in designing farming systems that mimic natural ecosystems to enhance soil health, biodiversity and overall sustainability.
Soil health management	Specialised	Proficiency in soil science and management is essential for sustainable agriculture. This includes knowledge of soil structure, nutrient cycles, soil erosion prevention, and soil conservation techniques.
Integrated pest management (IPM)	Specialised	Skills in IPM involve knowing how to combine techniques such as biological control, crop rotation, and selective pesticide use to manage pests and diseases while minimising harm to the environment and human health.
Water management	Specialised	Efficient water use and management are critical for sustainable agriculture. Skills in water conservation, irrigation techniques and rainwater harvesting contribute to reducing water wastage and promoting sustainable water resources.
Permaculture design	Specialised	Permaculture is a design philosophy that aims to create sustainable human habitats while working in harmony with nature. Skills in permaculture design involve integrating diverse elements such as plants, animals, structures and water systems to create self-sustaining ecosystems.
Sustainable livestock management	Specialised	Skills in rotational grazing, animal welfare, and waste management contribute to sustainable livestock systems that minimise environmental impact.
Community engagement	Socio-emotional	Effective communication and community engagement skills help promote sustainable agricultural practices within local communities. Educating and collaborating with other farmers, consumers and stakeholders can create a positive impact.
Policy advocacy	Specialised	Understanding agricultural policies and skilful advocacy of sustainable practices at local, regional, and national levels can drive systemic change and support the adoption of sustainable agriculture.
Resource efficiency and reuse	Specialised	The ability to minimise waste, optimise resource use and reduce energy consumption contributes to the overall sustainability of agricultural operations.
Fostering rural development	Specialised	Fostering rural development requires collaborative skills in developing and implementing strategies and initiatives that aim to improve the economic, social, and environmental conditions of rural areas. This is crucial for achieving balanced and sustainable growth across both urban and rural regions.

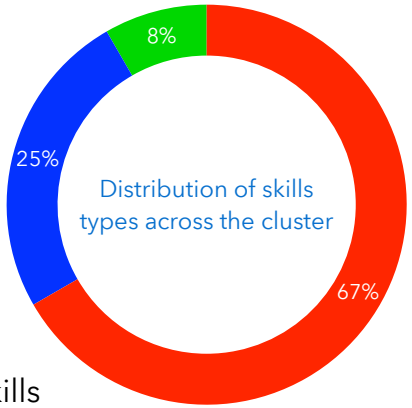
Robots and Cobots		
Skill	**Type**	**Description**
Human/robot interface design	Specialised	Understanding how humans and robots interact, including design principles for intuitive interfaces, is key for applications like service robots
Robotics engineering	Specialised	Skills in designing, developing and programming agricultural robots and cobots, including a deep understanding of robot kinematics, dynamics and control systems will be key
Programming collaboration	Specialised	Proficiency in programming and implementing cobots that can work alongside humans, ensuring safety, adaptability, and efficient task sharing will be a key skill.
Remote monitoring and control	Specialised	Skills in developing remote control interfaces that enable farmers to monitor, supervise, and guide robots and cobots from a distance.
Domain knowledge	Specialised	Understanding of agronomy, crop science, and farming practices to tailor robot and cobot functionalities to specific agricultural tasks and needs.
Safety protocols	Specialised	Knowledge of - and ability to apply - safety protocols, regulations and standards specific to agricultural robotics and cobots to ensure the well-being of operators, workers, and the environment.
Power management	Specialised	Expertise in optimising the energy consumption of robots and cobots, considering factors like battery life and renewable energy sources.



The skills required for future success in the Advanced Manufacturing and Engineering cluster fall into five categories

- Advanced manufacturing
- Engineering
- 'Core skills' - that is, skills which are required in both sectors in the cluster (Advanced manufacturing, Engineering)

There are 10 core skills: 6 are specialised skills, 1 is a foundational and higher order skill and 3 are socio-emotional skills.



- = Specialised skills
- = Foundational and higher order skills
- = Socio-emotional skills

Core Skills		
Skill	**Type**	**Description**
Cybersecurity	Specialised	With increased connectivity and Industry 4.0 technologies, safeguarding manufacturing systems and data from cyber threats will be crucial to maintain uninterrupted operations.
AI and machine learning	Specialised	Machine learning and artificial intelligence will enhance predictive maintenance, quality control, and process optimisation in advanced manufacturing. Being skilled in the development and application of these technologies will be crucial.
3D printing/additive manufacturing.	Specialised	As 3D printing continues to revolutionise production processes, understanding the principles of additive manufacturing and materials science and being skilled in applying them to engineering solutions will be vital.
Robotics and automation	Specialised	Automation and robotics are integral to advanced manufacturing for tasks like assembly, quality control and material handling. A strong grasp of robotics programming, AI-driven automation, and human-robot collaboration will be valuable skills.
Augmented Reality & Virtual Reality	Specialised	AR and VR technologies will play a significant role in training, maintenance and design visualisation in advanced manufacturing environments. Proficiency in developing and utilising these technologies will be beneficial.
Data analytics and visualisation	Specialised	Engineers who can analyse large datasets, extract insights, and present findings through effective visualisation will have a competitive edge.
Effective communication	Socio-emotional	Effective communication is key when explaining complex financial concepts to clients, colleagues, and stakeholders. Clear communication fosters trust and ensures everyone is on the same page.
Critical thinking and problem-solving	Foundational and higher order	Critical thinking skills enable individuals to analyse, evaluate, and synthesise information to make reasoned judgments and decisions. These skills are crucial for effective problem-solving, decision-making, and understanding complex issues.
Interdisciplinary collaboration	Socio-emotional	Advanced manufacturing often involves multidisciplinary teams. Effective communication and collaboration with experts from various fields, including engineering, design, materials science and data analysis, will be key.
Adaptability	Socio-emotional	The rapid pace of technological change means that professionals in advanced manufacturing must embrace continuous learning, adapt to new tools and techniques, and stay updated with industry trends.

Advanced manufacturing		
Skill	**Type**	**Description**
Materials informatics	Specialised	Professionals will need to be skilled in the custom application of materials science, data science and computational techniques to accelerate the discovery, design, and development of new materials.
Sustainable practice	Socio-emotional	As sustainability gains importance, designing eco-friendly manufacturing processes, effective waste reduction techniques and circular economy solutions will be required skills for future professionals.
Supply chain and logistics management	Specialised	Advanced manufacturing often involves complex supply chains. Skills in optimising supply chain processes, logistics management and real-time tracking will be essential.
Regulatory compliance and standards	Specialised	As technologies evolve, professionals will need to stay updated on industry standards and regulations related to safety, quality and environmental impact – and will need to apply those standards to design and production.
Creative problem-solving	Foundational and higher order	The ability to think creatively and find novel solutions to complex challenges will be highly valued.
Leadership skills	Socio-emotional	As projects become increasingly complex, leadership skills and project management expertise will be necessary to lead teams and deliver successful outcomes.

Engineering		
Skill	**Type**	**Description**
IoT and sensors	Specialised	Proficient skills in designing, implementing, and managing IoT systems and sensor networks will be essential for engineers working on smart cities, Industry 4.0, and other interconnected applications.
Digital twin simulations	Specialised	Engineers will need to be skilled in digital twin technology and simulation tools to create virtual replicas of physical systems, enabling real-time analysis testing, and optimisation.
Advanced material science	Specialised	Familiarity with emerging materials like graphene, metamaterials and biomimetic materials will be crucial for engineers developing innovative solutions in fields such as aerospace, nanotechnology, and renewable energy.
Sustainable design	Specialised	Expertise in renewable energy technologies, sustainable design principles and energy-efficient systems will be essential for addressing environmental challenges.
Biotech/ bioengineering	Specialised	The convergence of engineering and biology means engineers will need to be skilled at applying biotechnology concepts to the development of medical devices, tissue engineering and bioprocessing solutions.
Blockchain and cryptocurrency	Specialised	Knowledge of blockchain technology and its applications beyond cryptocurrencies, such as supply chain management and secure transactions, will be valuable.
Ethical hacking/ethical practice	Socio-emotional	With increased connectivity, engineers must have a strong grasp of cybersecurity principles to protect critical infrastructure and data from cyber threats. This may increasingly require skilled ethical hacking to test and correct vulnerabilities.
Societal awareness	Specialised	As engineers play a significant role in shaping society, a strong understanding of ethical considerations, cultural sensitivities and social impacts of technology will be crucial. Engineers will need to adopt and apply this knowledge to project design as and when appropriate.

The analysis set out in this section of the report has identified 17 core skills - required in each sector of a particular cluster - which the report finds are essential to the NI economy if it is to achieve competitiveness across all clusters. The 17 core skills are set out in the table on the next page.

One striking features of this analysis is the degree of crossover between core skills in each cluster. The 17 core skills break down into

- 11 specialised skills
- 5 socio-emotional skills
- 1 foundational and higher order skill

Six core skills are shared across all sectors (marked 1 in the table overleaf):

- Adaptability and standards
- Artificial intelligence and Machine Learning
- Collaborative working
- Critical thinking and problem solving
- Data analytics
- Effective communication

Three further skills – cybersecurity, ethical practice and QA and regulatory compliance expertise - are core skills across 3 clusters (marked 2 in the table overleaf)

We expect this degree of crossover to increase – possibly quite rapidly - as technologies converge.

Another striking feature of this analysis is the high representation of socio-emotional skills in the core group (and in individual segments within each cluster).

We expect, too, that the importance - and perhaps the breadth - of socio-emotional skills will continue to develop. Development of ethical practice, for example, is still evolving in AI and is expected to continue doing so in the foreseeable future.

While the application of these skills may vary - and perhaps vary significantly - between clusters and technologies, building these skills from an early age will be a critical foundation for future success.

This reinforces the emphasis in DfE's skills strategy that the core employability skills and range of higher level 'soft' skills that are key for sustained economic success are likely to change - and continue to change and evolve - in the future.

Core skills mapped against the five clusters

Skill	Type	Digital, ICT and Creative Industries	Fintec/Financial Services	Life and Health Sciences	Agritech	Adv Manufacturing & Engineering
3D Printing	●					●
Agricultural supply chain management	●				●	
Adaptability and standards 1	●	●	●	●	●	●
AI and Machine Learning 1	●	●	●	●	●	●
AR and VR	●					●
Bioinformatics	●			●		
Collaborative working 1	●	●	●	●	●	●
Continuous learning	●	●		●		
Critical thinking /problem solving 1	●	●	●	●	●	●
Cybersecurity 2	●	●	●			●
Data analytics 1	●	●	●	●	●	●
Effective communication 1	●	●	●	●	●	●
Ethical practice 2	●	●		●	●	
QA and regulatory compliance expertise 2	●		●	●	●	
Robotics and automation	●				●	●
Sustainability practice	●				●	
User interface design	●	●	●			

4. Developing the scenarios

Firetail undertook a series of interviews and workshop discussions to understand the structural characteristics of NI's economy and identify the strategic drivers of change shaping their development from the present day to 2035.

The drivers of change are organised into 8 categories:

- Economic wealth
- Social conditions
- Workforce composition
- Sectoral trends
- Working environment
- Education and training
- Prevailing social values
- International context

Through workshop discussion, the Steering Group reduced the long list to 16 key drivers that are strategically significant for NI's future.

These 16 factors are the **key uncertainties** that shaped development of the scenarios. Each one might develop in a range of ways and could therefore create a range of possible outcomes, opportunities and challenges for the NI technology workforce and wider economy. This range of possible outcomes is explored in the different scenarios.

The 16 key uncertainties are set out in the table on page 41. The range of possible outcomes for each uncertainty is presented as an 'axis of uncertainty' where

- One possible outcome is set out at the right-hand end of the axis
- The opposing possible outcome is set out at the left-hand end of the axis
- The 'middle road' outcome is set out in the middle of the axis

So, for example, one critical uncertainty is how much foreign direct investment (FDI) NI will attract in the future. One possible outcome is that the level of FDI will increase; another is that it will decrease; and, of course, it might remain stable.

This uncertainty is characterised in the table as follows:

← FDI increases // Remains stable // FDI Decreases →

The scenarios explore all of 16 uncertainties and their consequences for policy in NI.

Overall, the scenarios are designed to support discussion about NI's global competitiveness and, in particular, its ability to attract, develop and retain the high technology workforce it needs to be successful in the future.

The scenario framework is described on pages 59-61.

Category	Key uncertainty	Range of possible outcomes
Economic wealth	Level of foreign direct investment (FDI) into NI	← FDI increases // Remains stable // FDI Decreases →
	Global reach of NI specialisms	← Strengthens materially // Stays the same // Weakens materially →
Social conditions	Automation	← Many local-to-NI opportunities // Slow progress // Few opportunities in NI →
Workforce composition	Diversity in technology workforce	← Material progress to equity // Limited progress // Stagnation →
	Immigration	← High value talent attracted to NI // Fight for talent // NI suffers brain drain →
Sectoral trends	Uptake of innovation by NI businesses	← Tech led transformative growth // Incremental innovation // Stagnation →
	R&D spend	← Growth through public expenditure // Growth through private expenditure →
Working environment	Employment conditions	← Regulation benefits employers // Regulation benefits employees →
	NI's national infrastructure	← NI competitive in all areas // NI competitive in some areas // NI lags →
	Distribution of technology led gains	← Structure of tax, welfare and employment unchanged // Positive welfare by default // "Below the API" class are majority, poor conditions dominate →
Education and training	Uptake of lifelong learning (LLL)	← Significant increase driven by government policy // Moderate increase driven by individuals // No substantial increase →
	Structure of education, institutions, routes to education	← Online learning dominates // Market drives mixed models // In person learning dominates →
Prevailing social values	Office work environment	← Remote working dominates // Flexible working dominates // Office based work dominates →
International context	Post-pandemic, recovery/ Global Spending on Recovery	← Regulation benefits employers // Regulation benefits employees →
	Drive towards net zero	← All countries work together to make the global transition to net zero // Some countries fall behind in the global transition to net zero →
	Evolution and level of NI Executive's autonomy	← NI has increased autonomy // No change // NI has decreased autonomy →

The scenario framework was derived through workshop discussion with the Project Steering Group.

The purpose of the framework is to highlight the two most critical uncertainties facing the Northern Ireland economy as it looks towards 2035. Juxtaposing these uncertainties creates a 2x2 matrix that sets the parameters of the scenario logics.

The axes that frame the scenarios are derived from two key uncertainties from the international context.

The first uncertainty, Post-pandemic recovery/Global spending on recovery, relates to the international regulatory framework and how it achieves balance between the push for economic growth and the need to protect labour from exploitation.

The second uncertainty, Drive towards net zero, relates to the degree of international co-operation on achieving net zero and whether all countries progress together or whether some countries fall behind.

Firetail developed these *primary* axes further through discussion with the Project Steering Group to ensure they provided a rich framing of future uncertainties and possible developments that could shape globally competitive high technology sectors and workforce skills.

The final axes that emerged from these discussions were

- Application of technology
- Supranational collaboration

These are set out in detail on the following pages.

The first axis - supranational collaboration - relates to the uncertainty surrounding the global response to net zero and other emerging global challenges such as poverty, healthcare and global security.

One end of the axis describes a world of high spend on global challenges. There is widespread recognition that these global challenges are interlinked and can only be fixed if all nations work together. The scale of change required in economies is significant and expected to be difficult and unpopular with many electorates. A co-ordinated approach to economic development – including education and skills development - and to supporting the less well-off economies is seen to be key. The private sector is on board and large corporates are willing to align their efforts. This is not wholly altruistic – redistribution and increased global growth will create higher demand for goods and services across the board.

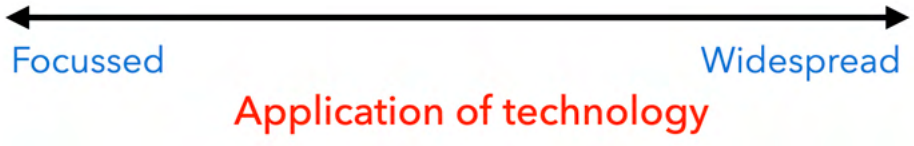
At the other end of the axis, spend on global challenges is low. Partly this is because there are fewer funds available due to competing priorities, but mainly it is because the international community has failed to agree terms for sustained development that all sides see as equitable. Smaller nations point to the high levels of consumption in developed economies that have contributed to global challenges and demand reparation for what they see as disproportionate impact. Larger nations, concerned about the increased fragility of markets and capital investments disagree. Global stability is challenged as new economic actors begin to emerge and strategic allegiances shift along geographic and cultural lines.

The second axis - application of technology - relates to uncertainty surrounding the uptake and use of technology to tackle global issues and to drive economic growth.

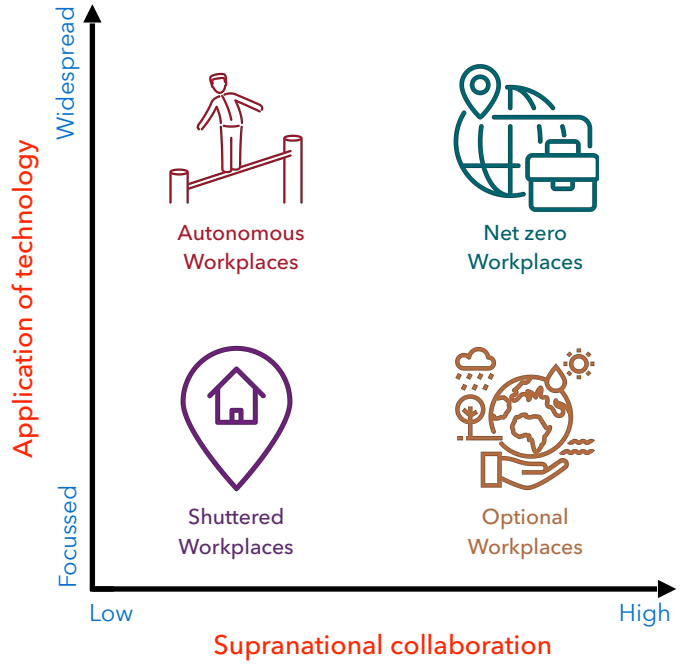
Focussed application of technology sits at one end of the axis. In this logic, technology is focused on tackling specific challenges or on creating specific competitive opportunities. This focus may be due to limited resources or because of competitive pressures (in the case of governments) or because of limited investment, closed markets or strategic targeting (in the case of businesses).

Technology is more likely to be owned by a small number of producers who may compete for market share or seek to control access through paywalls and partnership arrangements. Access may be restricted.

Widespread application of technology sits at the other end of the axis. In this logic, technology is more widely available and more widely shared. Partly this is cultural - the global economy is generally more open and nations are interested in collaboration - and partly it is expedient - nations need to pool resources to tackle significant global issues such as climate change and achieving a just transition.



Combining these two axes creates a scenario matrix that defines four alternative outcomes:



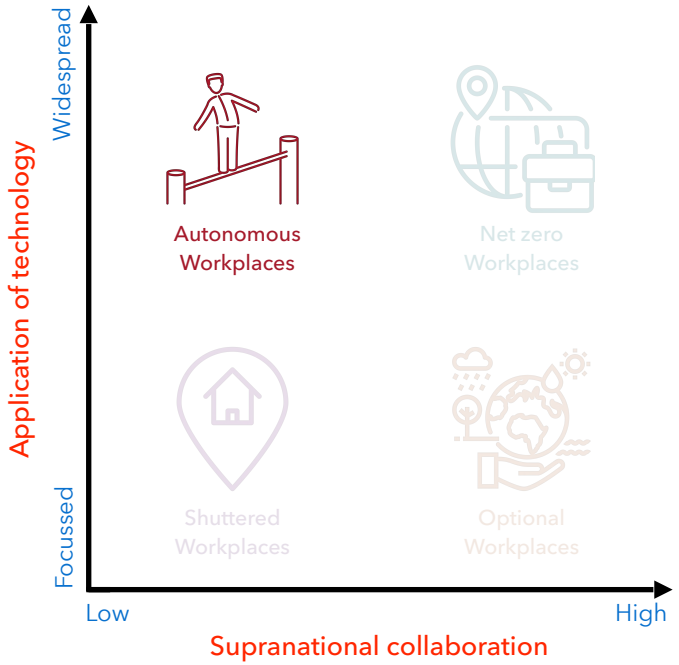
- Autonomous Workplaces describes a future where the application of technology is widespread and supranational collaboration is low. Technologies are used to manage workflow and cut costs. Human interaction has been removed from many parts of the economy. Governments mostly impose austerity; there are many opportunities for the private sector to plug gaps in public provision.
- Net Zero Workplaces describes a future where the application of technology is widespread and supranational collaboration is high. Talent is in demand and corporates and skilled staff work flexibly – whether remotely on in the workplace - and move constantly, fuelling city-level competition. Skill shortages and wage inflation accelerate in those regions that fail to attract talent.
- Optional Workplaces describes a future where the application of technology is focused and supranational collaboration is low. Economic activity and growth have slowed worldwide as governments focus resources on redesigning communities to support low carbon living and working. Public funding of technology is focused on supporting this endeavour. New tech development and deployment is driven by a collective sense of urgency.
- Shuttered Workplaces describes a future where the application of technology is focused and supranational collaboration is low. The world order is changing; the east is on the rise and the west moves in and out of recession as concerns over privacy, equality, bias and resource-intensity cause a societal backlash. International tensions rise as the east assumes control of - and access to - global solutions.

The tables on the following two pages provide an overview of the key points in - and key differences between - the scenarios.

Global Environment	Autonomous Workplace	Net Zero Workplaces	Optional Workplaces	Shuttered Workplaces
Scenario conditions	• Widespread application of technology • Low global collaboration	• Widespread application of technology • High global collaboration	• Focused application of technology • High global collaboration	• Widespread application of technology • Low global collaboration
Economic growth	• Steady	• Rising	• Reduced by choice	• Uneven across nations
Markets	• Highly competitive	• In transition to net zero • Strong local focus	• Committed to a just transition • Collaborative	• Short termist
Society	• Individualistic and unequal	• Disrupted	• Physical restructuring	• Loss of trust in government and business
Technology	• Pervasive • Owned and controlled by a small number of global corporates	• Pervasive • Distributed	• Concentrated • Threat of restricted access	• Concentrated in the global east and south

Northern Ireland	Autonomous Workplace	Net Zero Workplaces	Optional Workplaces	Shuttered Workplaces
Economic growth	• Slow	• Strong	• Low	• Flat
Government	• Picks winners • Invests in innovation	• Focusses on transition to net zero • Sustained investment in comms infrastructure	• Reforms public service provision to make digital • Supports levelling down	• Directive • Struggles to regain the electorates' trust
Prominent technologies	• Cybersecurity • Software • AI	• Precision agriculture • Precision medicine/diagnostics • ICT	• Embedded sensors/analytics • Centralised energy production and smart grids. • Digital public services	• Communications • Defence/AI • Cybersecurity
Skills growth	• Focused on limited strategic specialisms • Strong focus on building progression routes	• Developed by first attracting high skill mobile talent to NI • … followed by post transition local skills development	• Driven by infrastructure development • Government and private sector collaborate on strategic skills development	• FE/HE curricula are highly focused on strategic sectors • Emphasis on core skills escalator
Businesses	• Collaborate with government, FE and HE to build the skills pipeline	• Re-engineer processes, supply, chains and routes to market to achieve net zero	• Sustain investment but scale down ROI • Social returns as important as economic ones	• Active engagement and skills, development and course design
Social cohesion	• At risk due to the precariat	• Strong due to employment opportunities	• Strong in the greater global good • Reformed welfare system creates a social safety net	• Sceptical of government • Disenfranchised • On edge of social breakdown

5. The scenarios



Autonomous Workplaces describes a future where the application of technology is widespread and supranational collaboration is low.

Markets are highly competitive. Societies are individualistic. Governments are directive. Competition is fierce.

The global situation

Overall economic growth is steady but the headline figure masks significant differences in national prosperity. Following a decade of economic uncertainty and the rising cost of climate adaptation, governments have limited funds available for wider public services.

The market provides services to consumers and regions that can afford them. Competition is high and the leading corporations have invested heavily in technology to increase service quality and reduce ongoing costs. The number of transactions requiring a human intermediary has declined significantly. So, consequently, has employment.

Societies are unequal. Capital owners and skilled workers (those in occupations with a high knowledge and creative content) do well. Those with limited or out of date skills struggle to stay in employment and have limited options. If they are lucky, they live in countries that continue to provide a social safety net; but the number that do is declining. So are overall health and welfare budgets.

A new underclass has emerged. The precariat - the once middle income, middle skilled white-collar workers who are being replaced at speed by technology - work in those commoditised segments of the economy where short term contracts dominate and where employers take little or no responsibility for their workforce.

Technology is pervasive and is owned and controlled by a limited number of global corporations. The key growth areas are in high end personal services such as security and wellness for those with money; education and virtual hangouts for those with aspirations; and clickbait consumerism and wall to wall entertainment for the wider population. Technology work is concentrated in key clusters around the world. These are highly connected but not necessarily geographically proximate. Cybersecurity is essential for individuals, for business and for access to markets.

Firms generally rise or fall by their own efforts. Governments have limited funds to offer support to meet skill shortages or market failure. Churn is high in certain economies. Strong economies have an entrepreneurial culture that makes it easier to begin again.

The Northern Ireland economy

The Northern Ireland economy slowed significantly in the mid 2020s as it sought to recover from the double whammy of Covid-19 and EU Exit. The policy landscape was defined by fiscal difficulties and sustained political challenges that gave little room for manoeuvre.

Government nevertheless sustained its focus on technology as the way to economic security. Doing so meant making some tough policy choices – there simply wasn't enough money to do everything – and the pressure to deliver upped the ante. In this challenging environment, government had no option but to pick its likely winners; and no option but to invest in the innovation infrastructure they needed to succeed in the long term. Limited funding meant that investment had to be laser focused on areas of high strategic priority. NI was clear from the get-go that it wasn't going to make the same mistake as those governments that tried to maintain a broad-brush approach and ended up spreading its money too widely and too thinly to make a difference.

These were difficult choices to push past those who argued that the needs of existing businesses should take precedence over future aspirations that might – or might not - deliver; but government held its line. NI's success, then, is due in part to government's willingness to make those tough calls; but also to the effective partnerships that have emerged over the last decade or so.

Foremost amongst these are the Regional City and Growth Deals secured in Belfast and Derry-Londonderry that have delivered growth in three priority domains - cybersecurity, software and AI. The City and Growth Deals have been instrumental in freeing university-led research and development projects to generate thousands of high-tech jobs over the last 10 years.

Skills growth has been underpinned by significant capital investment and expansion beyond the Belfast Derry region to Strabane and Newry. The resulting tech corridor includes innovation nodes that link further afield to Dundalk and Dublin.

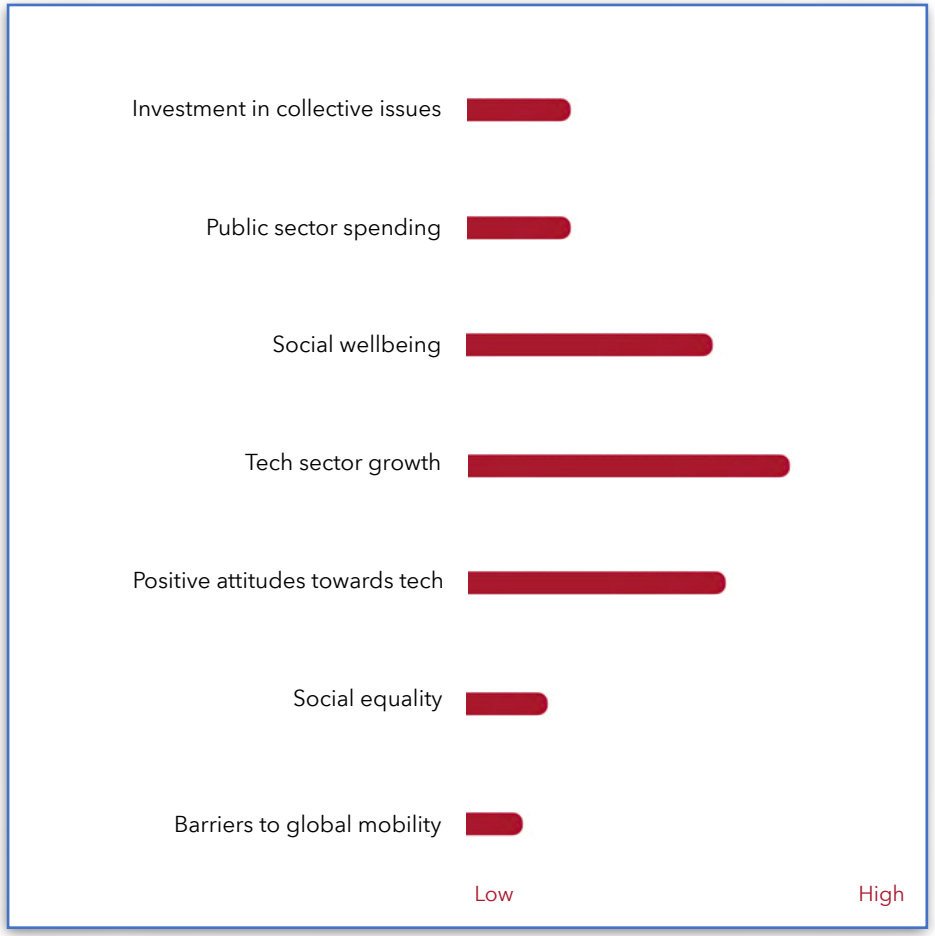
As is the case in other successful parts of the world, NI's government has been directive, building tight partnerships and employment channels between industry and the HE and FE sectors. NI pushes as many people into highly skilled roles as possible.

Unlike many of its competitors, however, NI has chosen not to let its less skilled workforce languish in jobs with little future. Instead, it has encouraged social responsibility across the tech sector, encouraging businesses to create progression routes for those precariat workers who – in other economies – have fallen by the wayside.

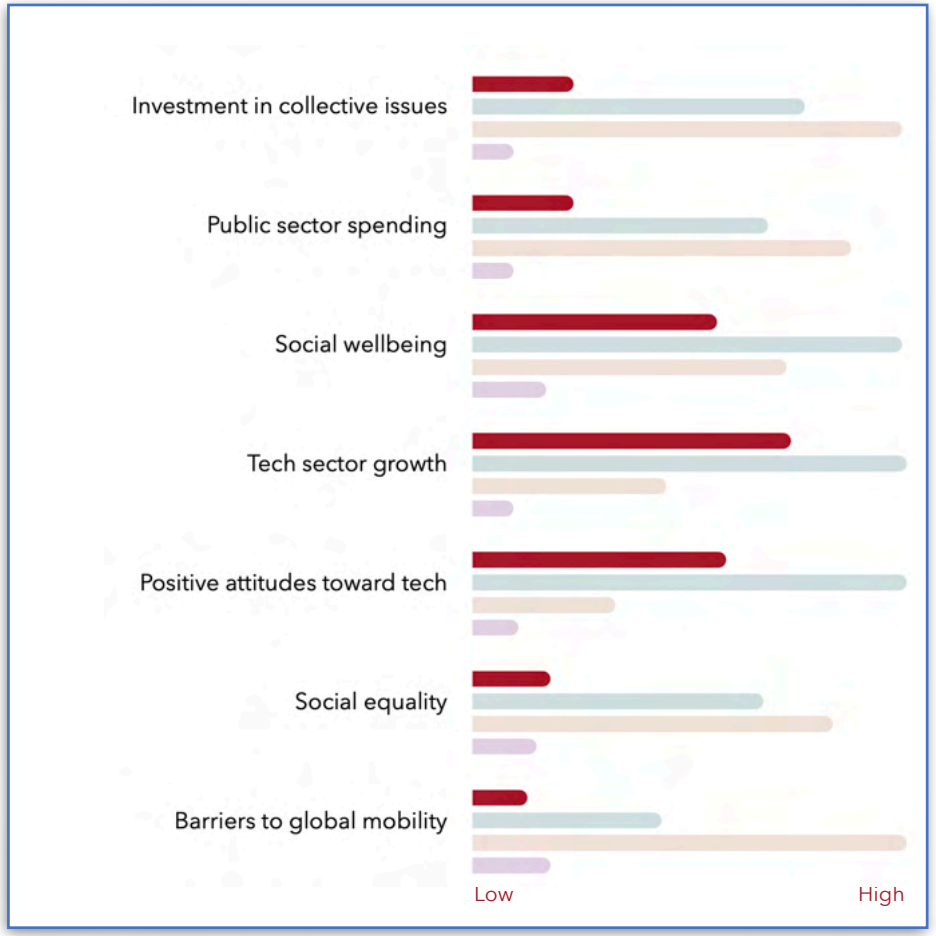
Government may have decided on this policy for social reasons in the first instance; but it has been unexpectedly successful in economic terms as well.

Key characteristics of Autonomous Workplaces

Key scenario features

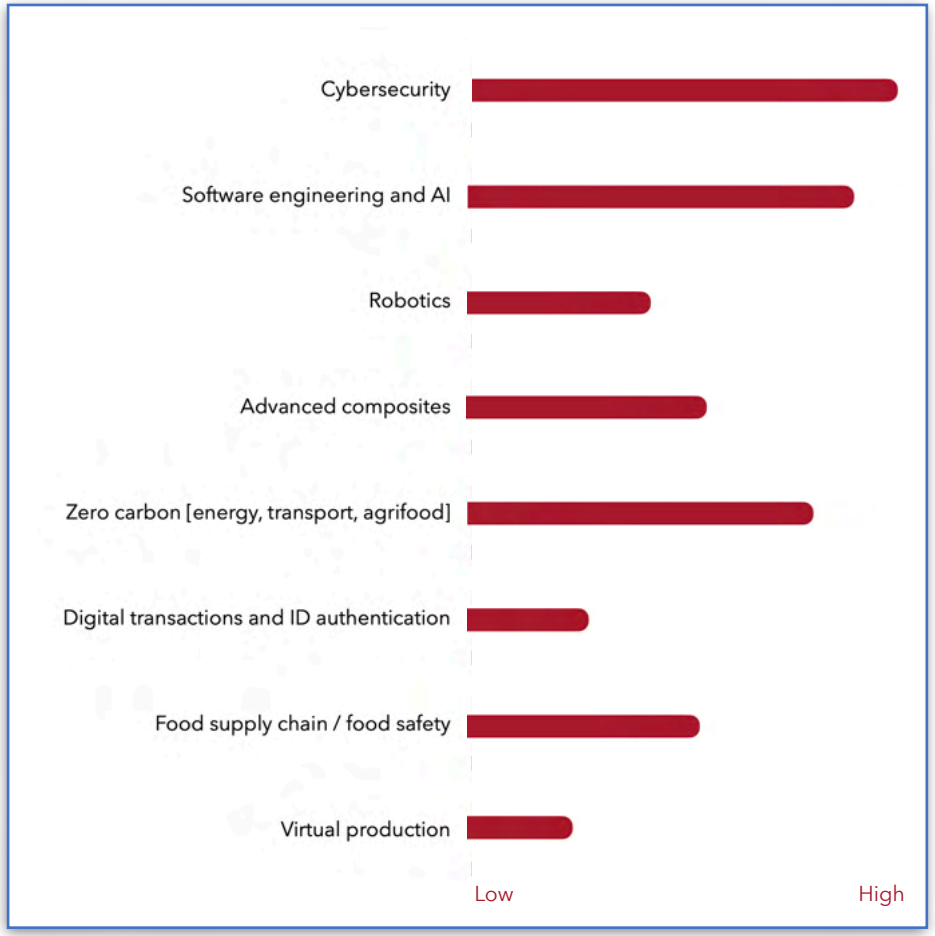


Comparison of key scenario features

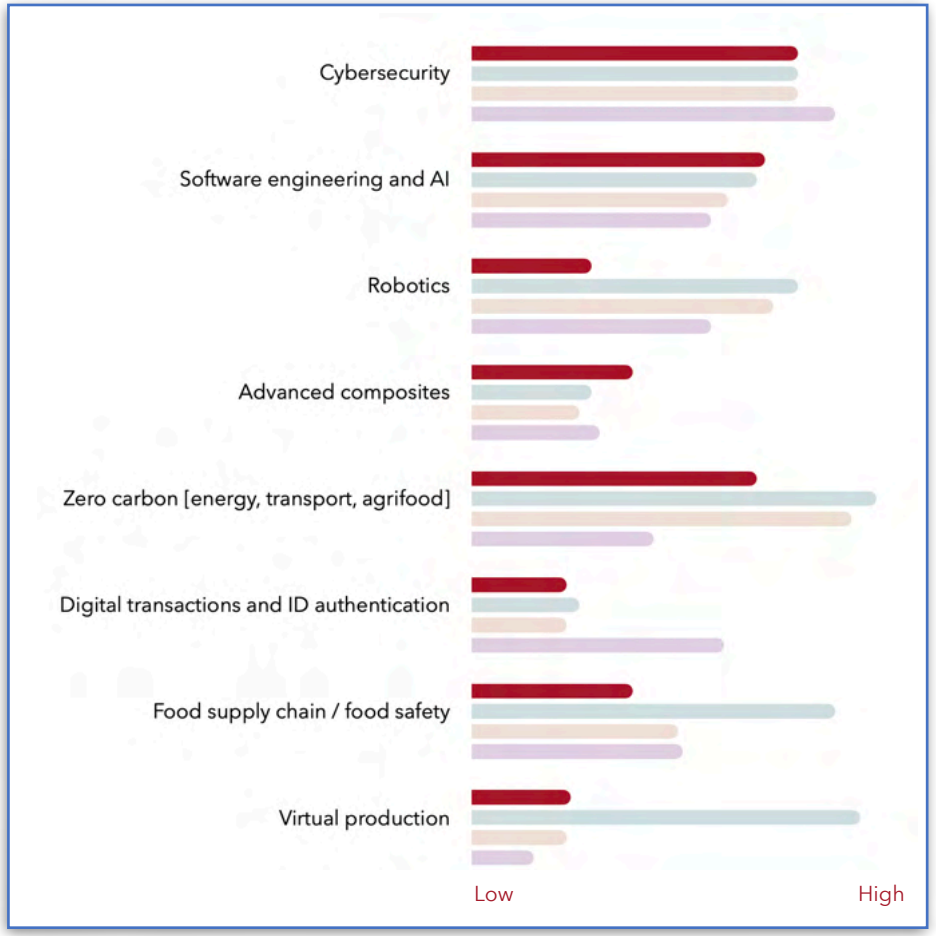


Key characteristics of Autonomous Workplaces

Prominence of key technologies



Comparison of key technologies across the scenarios



Prominent technologies

AI and behavioural science is used to understand sentiments and preferences

Digital personalisation drives competition in consumer markets

Human/computer interfaces increase productivity

e-Government drives cost savings in the public sector

Cybersecurity protects digital footprints, particularly for the most wealthy

Longevity science offers regenerative medicine and cryonics to the ultra wealthy

Personalised health monitoring and advanced diagnostics uses wearable devices and sensors to continuously monitor individual health metrics

Genetic Testing and Precision Medicine identify individuals' genetic predispositions to disease. Personalised therapeutics tailor treatments to genetic makeup, maximising efficacy and minimising side effects

Nanomaterials with unique properties, such as self-cleaning surfaces, enhanced durability, and improved strength-to-weight ratios are used in luxury product

Smart materials are used to create luxury interactive wearables that change colour, display content and provide biometrics

Sustainable luxury items - such as lab grown diamonds, pearls and fabrics - are in demand by global elites wishing to consume sustainably

Commentary

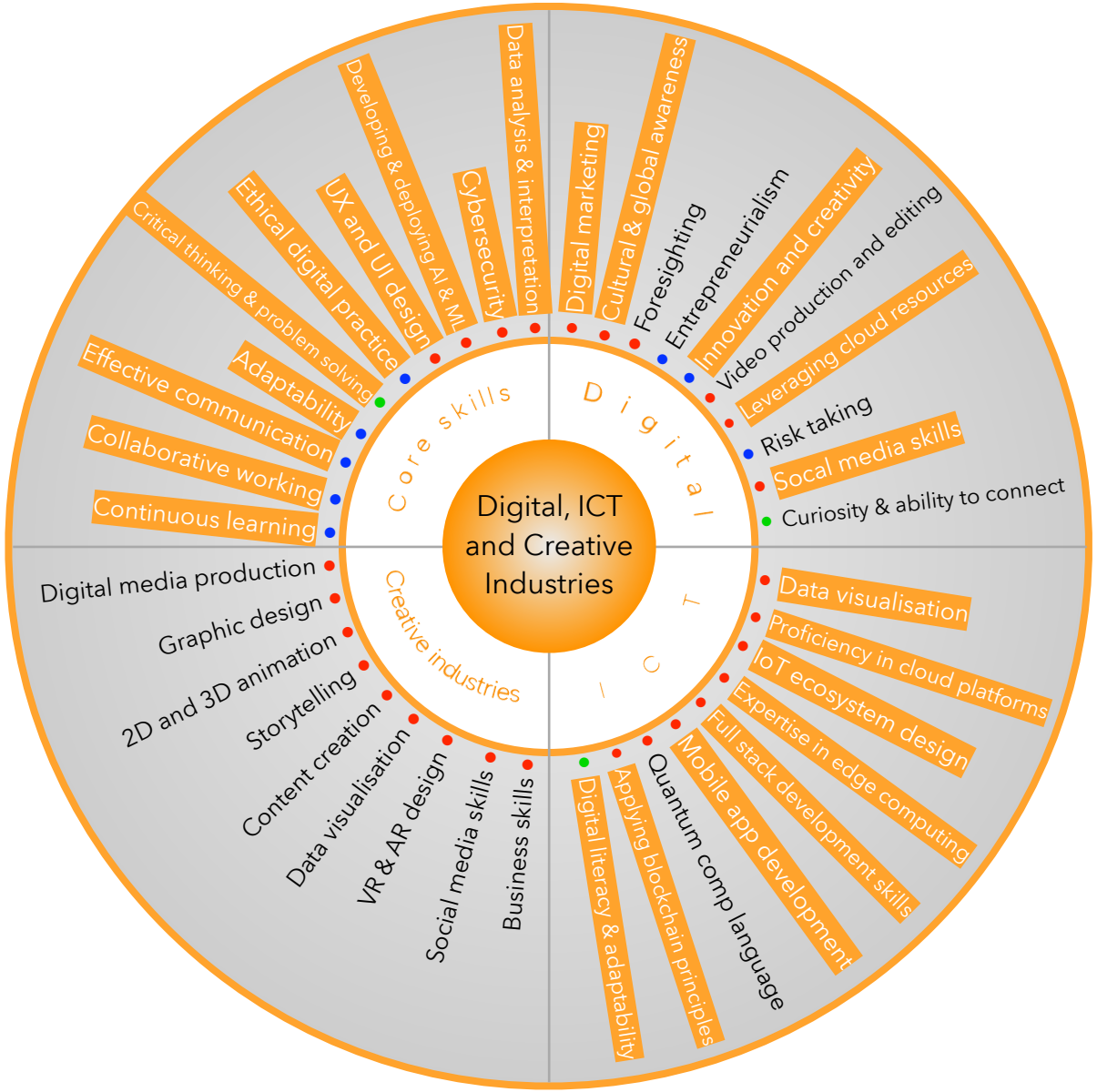
The Digital, ICT and Creative Industries cluster is the key driver of NI's future success in this scenario - although the cluster itself changes due to the limited importance of the creative industries.

Life and Health Sciences and Advanced Manufacturing and Engineering remain important clusters in their own right, with investment directed towards those aspects that support the wider policy goal of making NI a high value service economy.

Agritech and Fintech have less strategic value to NI in this scenario. While this doesn't mean that the clusters will disappear, it does suggest that investment in technology - and the education and training infrastructure - should not prioritise skills development in these areas. Some core skills are, of course, transferrable from other clusters.

The scenarios are not predictions, projections or an assessment of current government policy

Key skills required to succeed in Autonomous Workplaces



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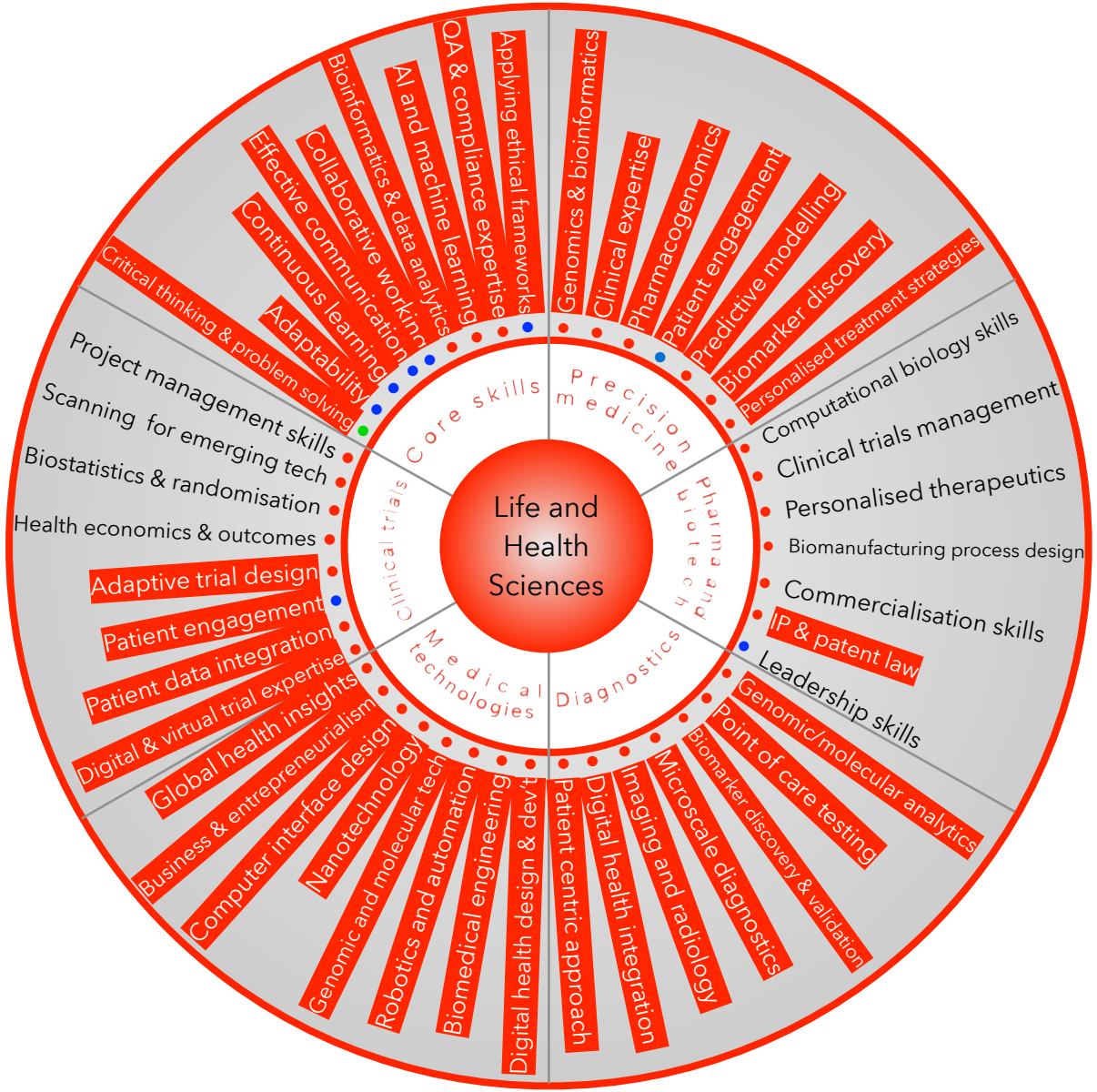
Key skills required to succeed in Autonomous Workplaces



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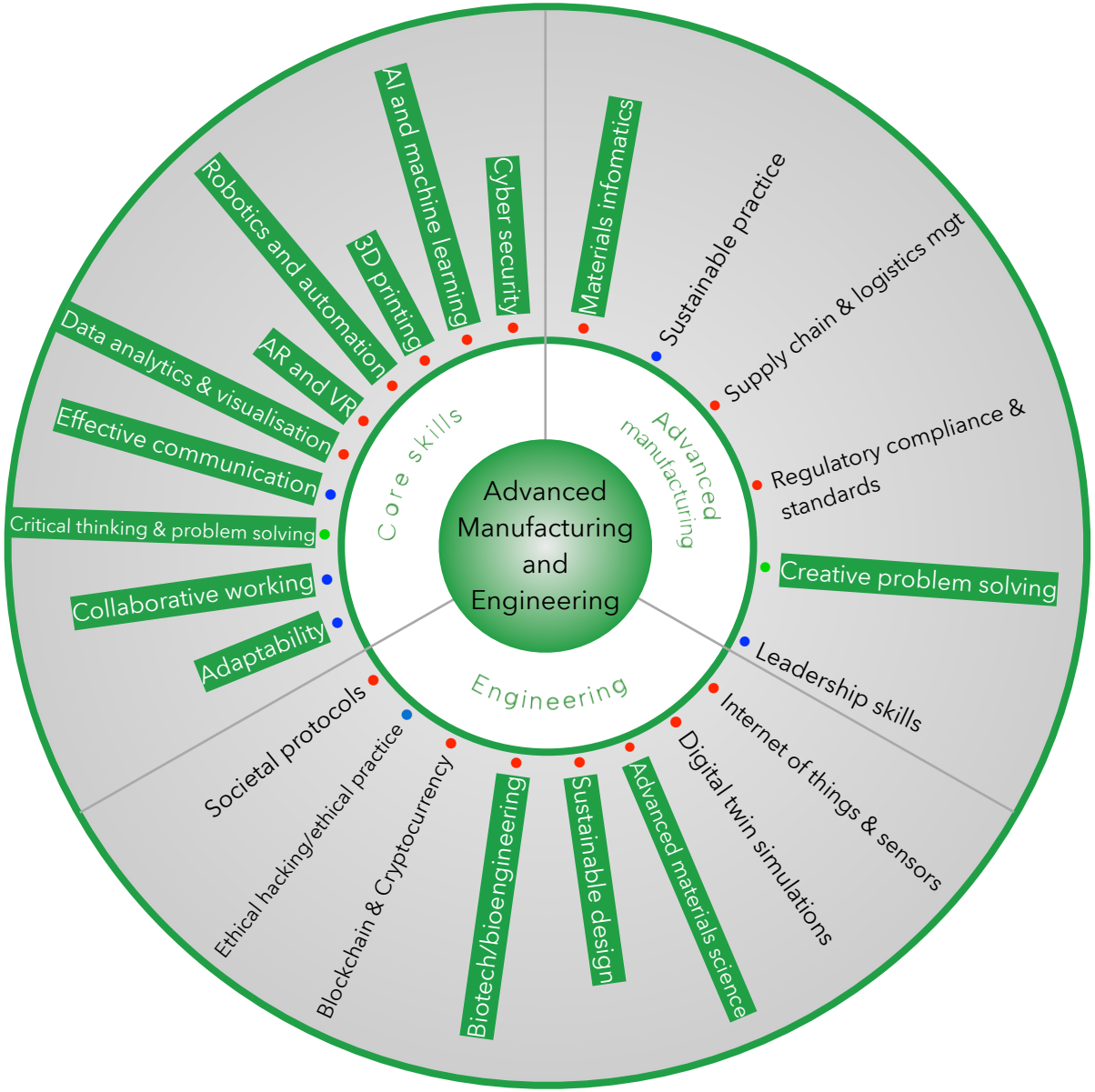
Key skills required to succeed in Autonomous Workplaces

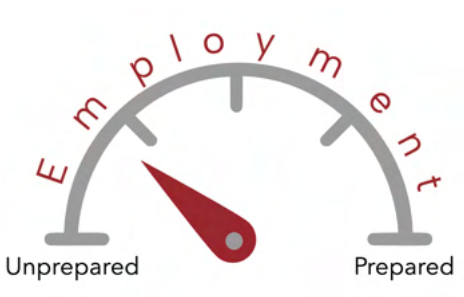


The scenarios are not predictions, projections or an assessment of current government policy

Fit of the 2023 NI skills base with the skills required to succeed in Autonomous Workplaces

NI's current skills base is reasonably balanced in respect of this scenario - but the current pipeline of talent must be maintained. In particular, NI needs to ensure the pipeline provides core skills across the three dominant technology clusters that it focusses on to drive success in this scenario.

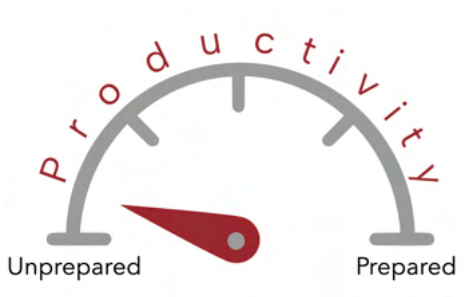
The two key risks for NI in this scenario are that it over invests in the two less important clusters; and that it underinvests in the three that are most important - causing NI's most talented workers to move away.



The key risk for NI in this scenario is that technology will replace low to medium skill workers rapidly across all sectors - creating NI's precariat class.

Youth and adult unemployment will increase significantly without policy foresight and a co-ordinated, flexible response to address the challenge before it becomes systemic.

Creating progression routes for precariat workers and the lower skilled through targetted training will be key - but will not in itself be sufficient to address wider unemployment issues.



Success in this scenario requires boosting productivity through sustained investment in the right technologies and continuous training across the life course in core skills across all key sectors.

Government has less power in this scenario and skills policies will need to be developed alongside employers. They are likely to be demanding of the skills infrastructure and will require government to adapt - and invest in - policies quickly.

Failure to do so will risk losing employers to more productive regions.

This scenario poses a challenge to the welfare system - not just to funding, but also to effective work coaching.

Successful management of the precariat and low skilled workers will require a progressive approach to welfare. The system will need to focus on skills development rather than job placement and should target only those who are employable. It will require a properly resourced work coaching programme which invests time in suitable individuals.

The scenarios are not predictions, projections or an assessment of current government policy

Delivering success in Autonomous Workplaces

Position the high tech sector for success

1. **Invest in one or two specialisms that cater to a high-income global elite:**

   Demand amongst the global capital owning class for personal services and facilities in digital security, personalised life sciences and rural estates will increase. NI could offer, for example,

   - top-end personalised cyber security for the elite
   - high-cost precision medicine for international visitors and the highly connected
   - high-tech wellness retreats embedded in rural settings

2. **Seek to lead in the next global process outsourcing wave**

   High volume, low/medium value-added roles are particularly valuable in this scenario. NI should capitalise on opportunities to create advanced high end service centres utilising first threshold human-in-the loop processes linked to (for example) customer service, medical diagnostics and support, online content moderation and data labelling for AI.

   With state support, these businesses could be encouraged to create internal progression/management hierarchies to help lower skill level workers move up value add skills ladder, clearing space for precariat workers to join the skills pipeline.

3. **Promote access to appropriate collective community support**

   Public/private sector support for collective community tech includes crowdsourcing ideas, peer to peer upskilling, local skill sharing platforms and Co-working opportunities.

   These initiatives create specific - but informal and low key - opportunities for precariat workers to take the first steps back onto the skills ladder.

4. **Work alongside the private sector - which has stronger influence over skills investment and greater ability to invest**

   The public sector can regulate and create minimum standards for employee skill development, but may only have limited funding for skills system. It should target spend carefully to support strategic industry and to leverage their investments into a targeted skills programme.

Delivering success in Autonomous Workplaces

Invest in skills to support tech success

1. **Shift the emphasis in HE to higher skills employment pipeline**

   Collaborate with big tech owners to ensure workers have skills to compete for places in highly skilled work, including routes into high productivity and high value firms.

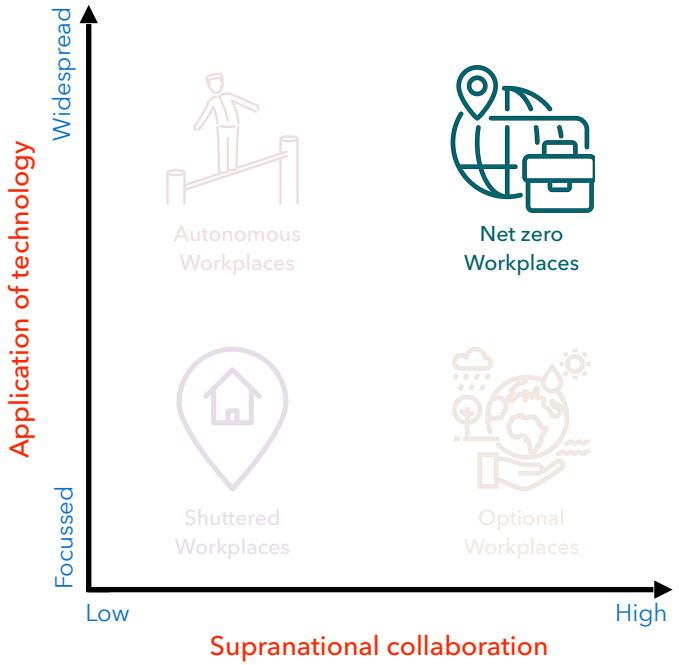
2. **Shift FE towards supporting vocational learning with routes to high skilled (e.g. level 4+) work**

   Focus on areas of the economy where there is growth and more stable work, with greater levels of personal ownership, and greater options for personal progression.

3. **Use lifelong learning budgets to support less skilled workers**
   - Establish skills portfolios / passports for freelance workers
   - Develop and utilise flexible learning approaches to remove barriers to learning for freelance workers
   - Utilise virtual, asynchronous learning to help freelance workers make use of unpredictable, short slots of available time for learning
   - Scaffold this approach into credentials that help freelancers move out into more stable employment.

4. **Meet the need for assistance in job search process for flexible workers**

   Establish government platforms for finding opportunities, matching skills, moving workers to the opportunities that best match their skills and provide the best opportunities. Focus of employability support is survival and quickly finding work.



Net Zero Workplaces describes a scenario where the application of technology is widespread and supranational collaboration is high.

Barriers to trade and movement of skilled labour are low. Governments adopt a laissez faire approach designed to drive innovation and growth. Corporates compete to reengineer business models for net zero growth.

connectivity, low carbon emissions and strong public services. Access to markets is key and net zero infrastructure and transportation confer regional advantage.

The Northern Ireland economy

The Northern Ireland economy is strong. The region is a world-leading location for digital freelancers, attracting the global elite workforce through its combination of exceptional connectivity, strong infrastructure, world class research institutions and high quality of life.

None of this has fallen into Northern Ireland's lap. While the region's progressive approach to net zero gave it an early advantage, it is the sustained investment in infrastructure and services that has helped it pull away from the competition. The comms infrastructure supports the VR and spatial computing solutions that are key to virtual collaboration; intelligent induction charging transport infrastructure keeps people moving and AI tools support productivity and creativity.

Another key factor in NI's success has been its specialisation. It has not – unlike some regions – tried to be all things to all comers but has concentrated on a few key strategic sectors. It has focused on the transition to net zero and climate change resilience and is today a leading proponent of nature positive agriculture.

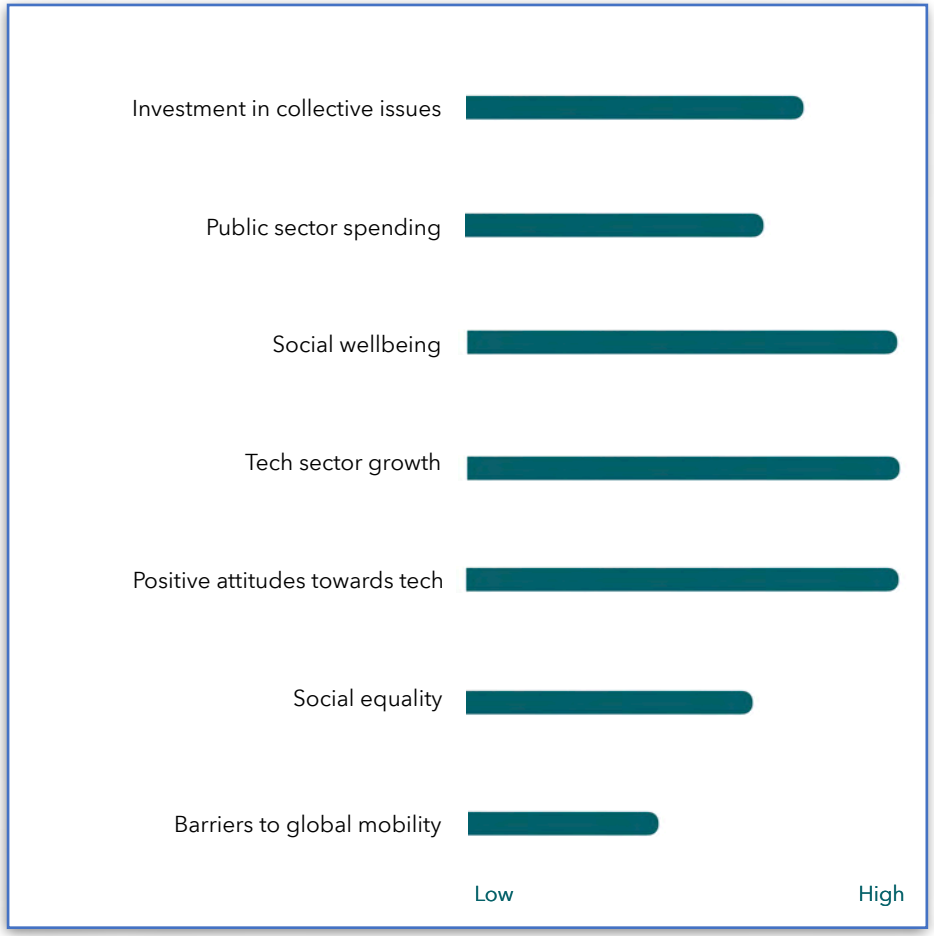
Belfast and the corridor to Dublin are a must have location for global firms' innovation hubs and here, in particular, the investment in the intelligent highways corridor has created new opportunities for regional inclusion. Small communities along the corridor have been revitalised and the region has become progressively wealthier and more balanced as skilled workers with disposable incomes have moved to its desirable rural locations.

Locations, of course, that enjoy the net positive infrastructure that now makes living and working in Northern Ireland highly desirable.

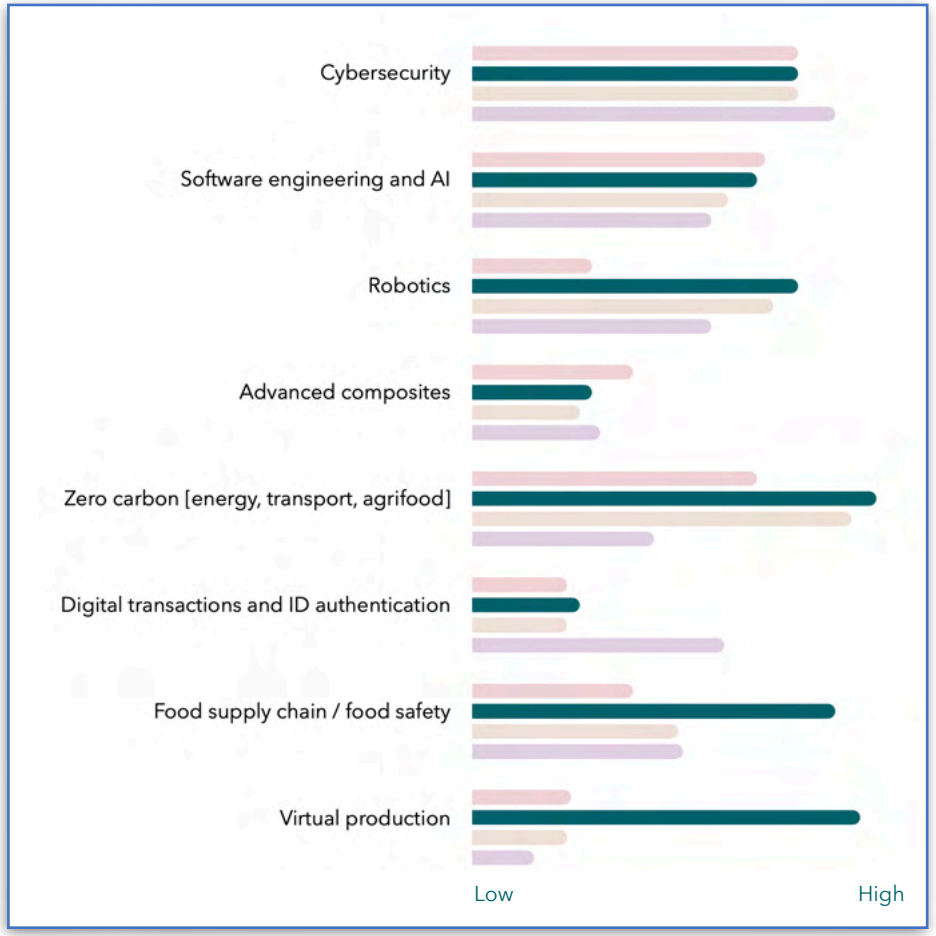
NI has a strong service economy that supports its tech sectors and is key to sustaining Northern Ireland's competitive advantage in attracting mobile workers. It has strengthened those sectors, too, where virtual working is limited or non-existent. Personal care is a particular exemplar: services are targeted across the whole life course and jobs are well paid. Training is an essential element of care development and staff are required to upgrade their skills regularly. Here, too, the benefits cross over directly to the workforce – employers and workers can utilise physical and mental wellness tracking to optimise individual wellbeing and collective productivity.

Key characteristics of Net Zero Workplaces

Key scenario features

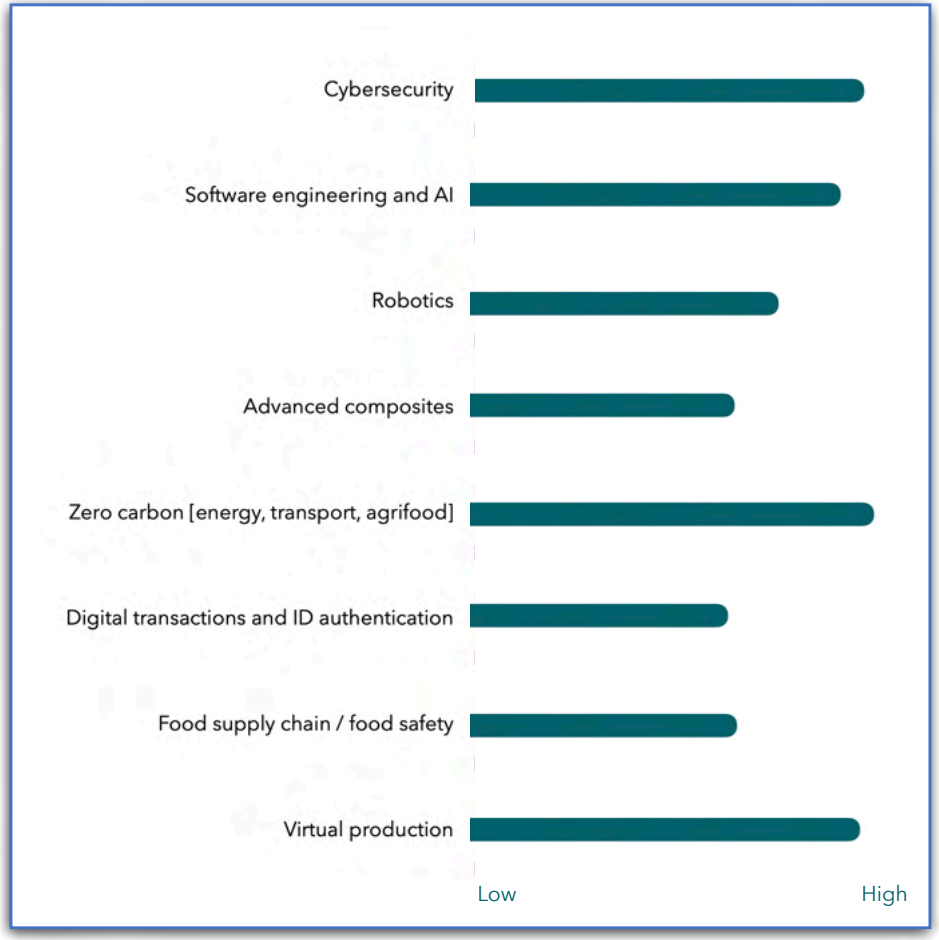


Comparison of key scenario features

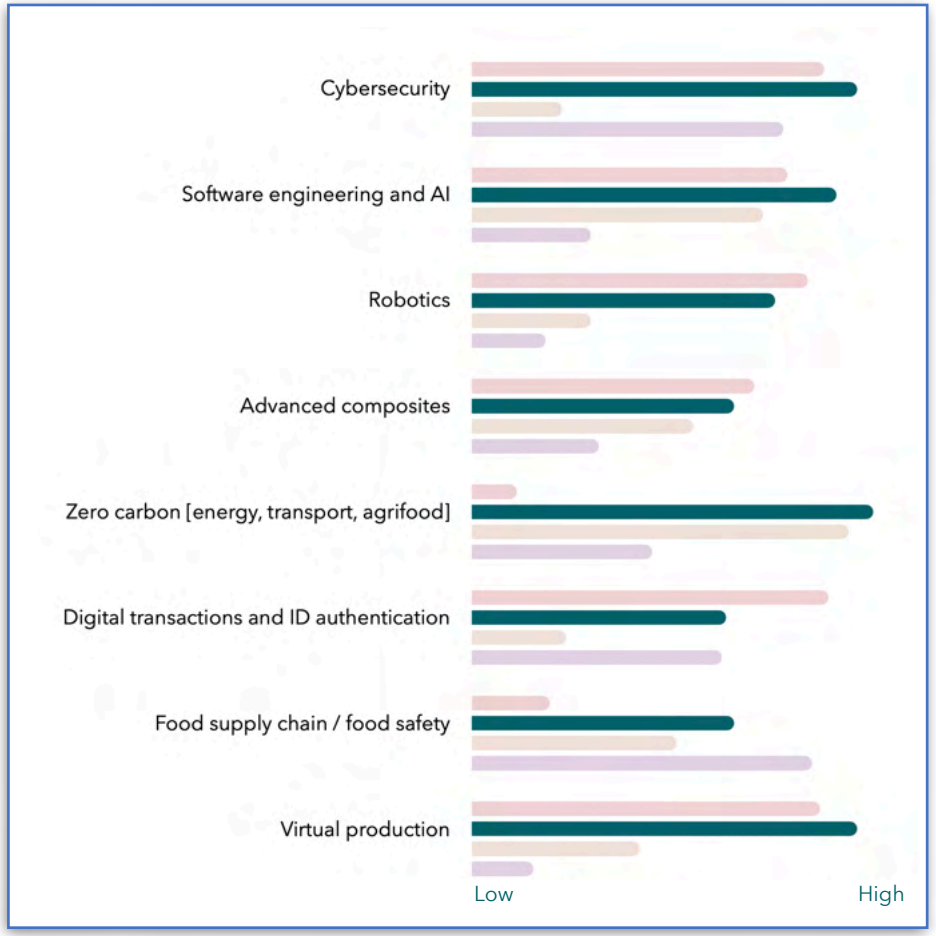


Key characteristics of Net Zero Workplaces

Prominence of key technologies



Comparison of key scenario features



Prominent technologies

Agritech

Intelligent agriculture is developed by applying sensors/data analytics/internet of things technologies across all stages of the food chain

Low carbon agriculture focusses on reducing emissions through selective breeding, genetically modified feeds and methane inhibitors

Tackling disease resistance and food yields

Protecting and restoring biodiversity

Deploying circular agriculture to put byproducts - from crop residues to dairy manure - back into the system

Digital, ICT and Creative Industries

Cybersecurity is critical for keeping data secure and systems operating

VR and spatial computing solutions are key to virtual collaboration

AI tools support productivity, creativity and task completion

Mobility as a Service keeps travel easy and efficient

Life and Health Sciences

Physical health and wellbeing are monitored across the life course. This is a key attractor for NI

Mental health and wellbeing are monitored across the life course. This is used in particular to support workforce productivity

Advanced Manufacturing & Engineering

Intelligent induction charging transport infrastructure keeps people moving and batteries charged

Fintech/ Financial Services

Commentary

Success in this scenario - and, more importantly, securing competitive advantage in a fast-moving world - requires NI to move rapidly to acquire the technologies and technology skills it needs.

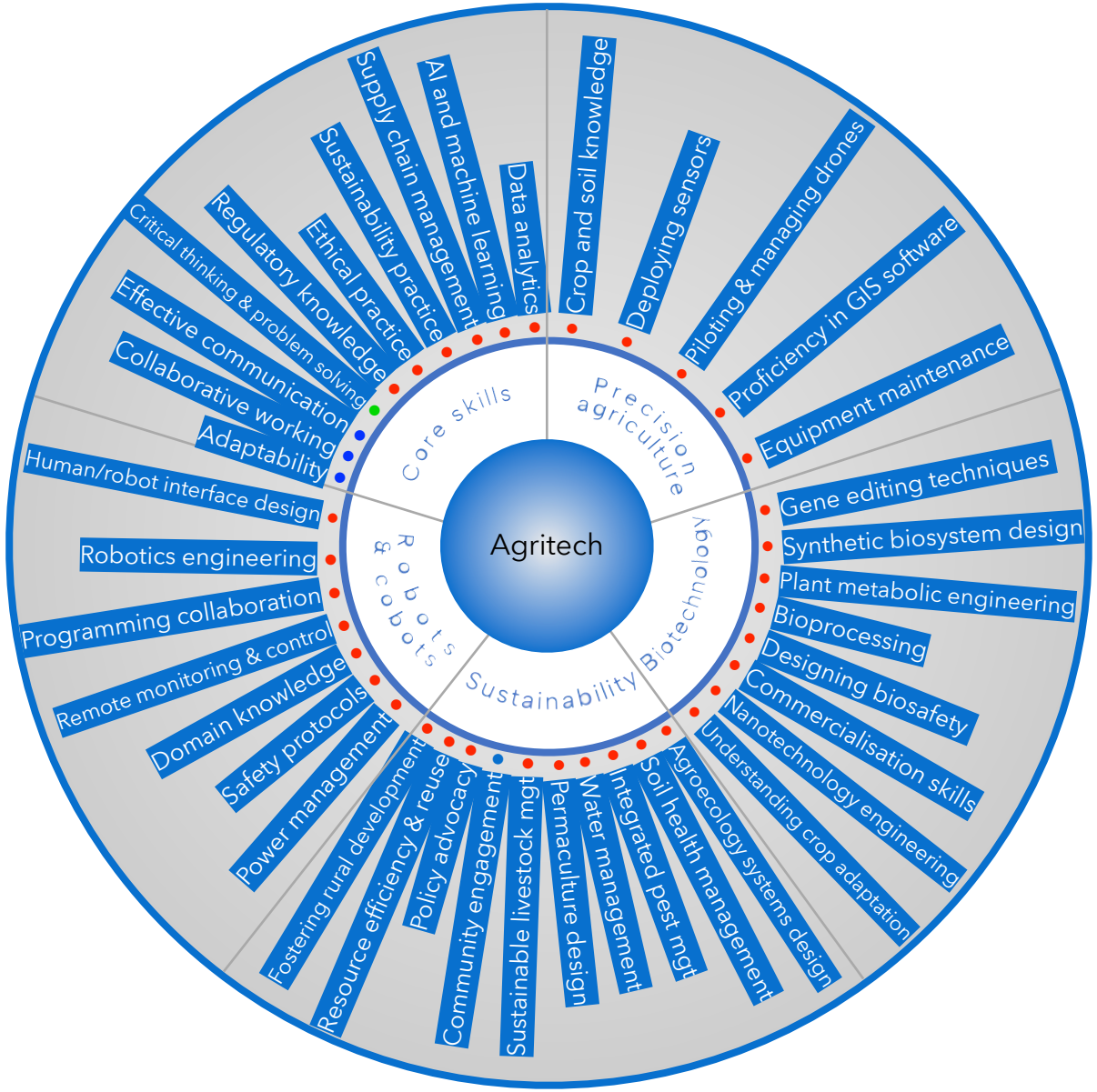
This means attracting businesses and individuals with the right skill set to come to NI. It also means focussing on the strategically important technologies and pulling back from some which might dilute resource and perhaps have less contribution to make to NI's journey towards net zero.

Creative Industries are strong in this scenario because of their importance to attracting high value mobile workers.

The skills maps on the following pages indicate the breadth of skills that NI will require to thrive in this future. Matching these against the current baseline will indicate which skills NI needs to prioritise.

The strategy of attracting skills in removes the need to develop them directly and frees up local labour to build the service economy that NI will need to support these developments. Making these jobs attractive and valued will require more than competitive salaries - although these too will be essential - and will need to be driven by a cultural shift that celebrates service jobs as a fundamental piece of the platform for making NI one of the foremost locations in the world.

Key skills required to succeed in Net Zero Workplaces



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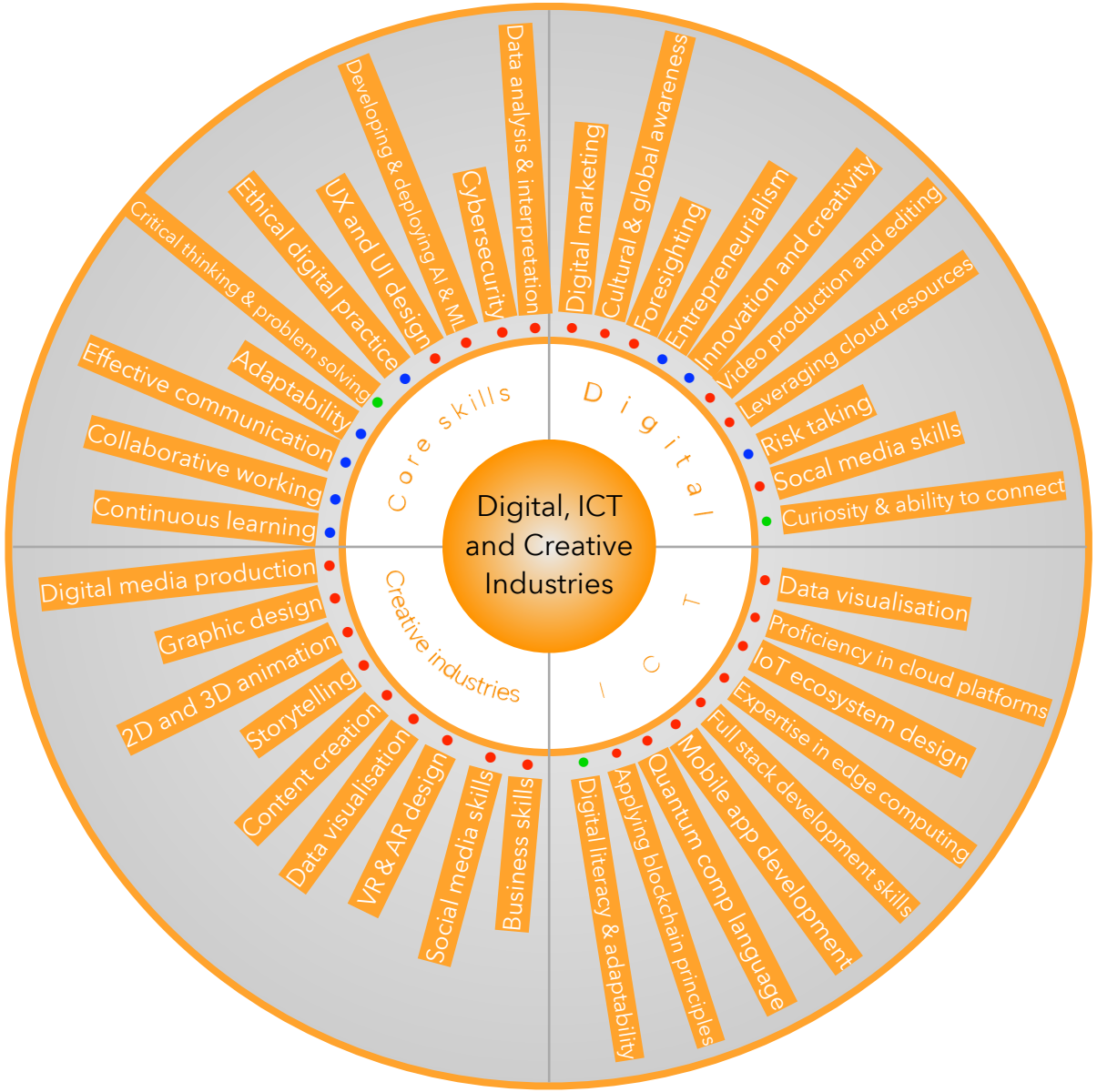
Key skills required to succeed in Net Zero Workplaces



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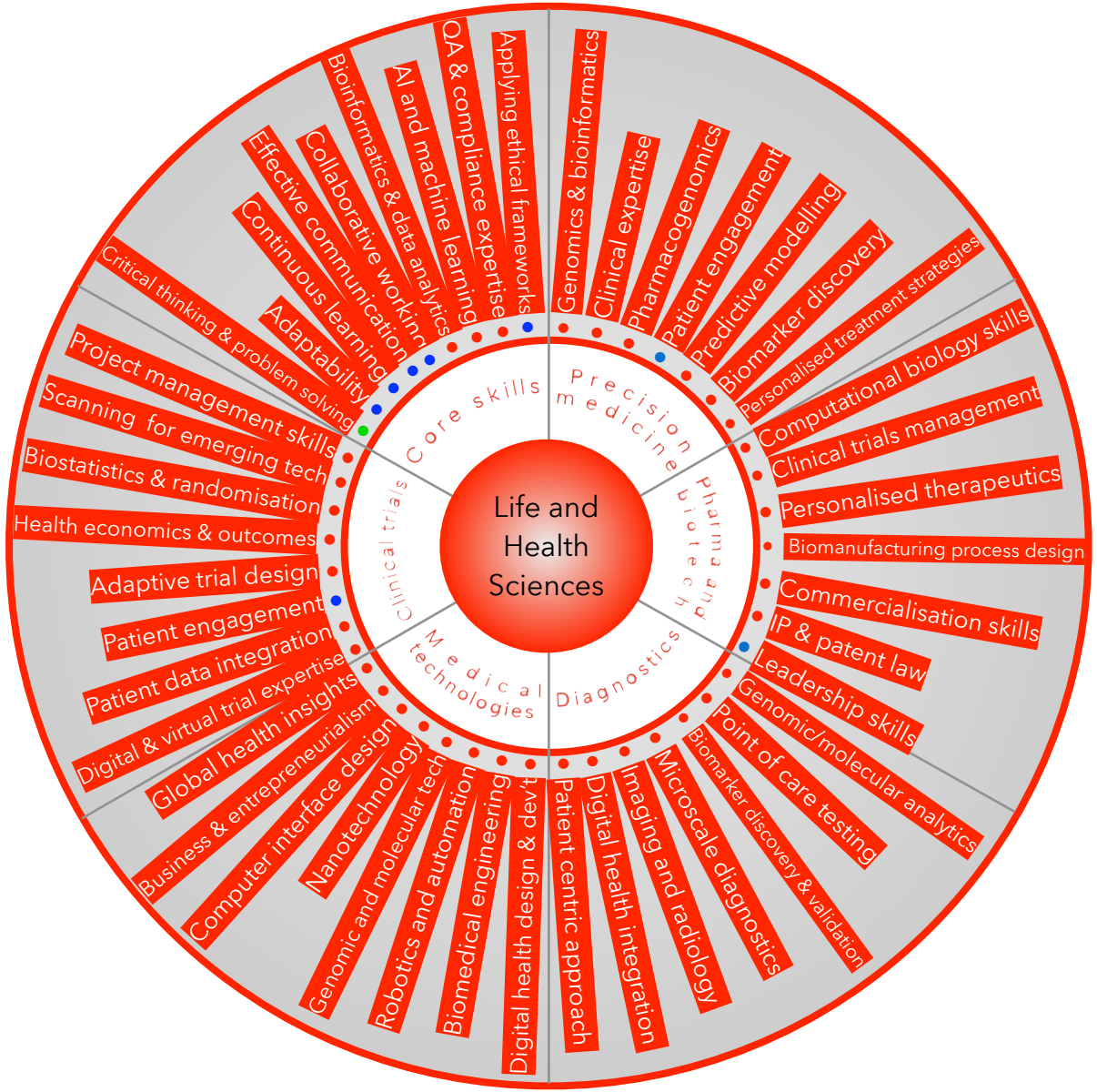
Key skills required to succeed in Net Zero Workplaces



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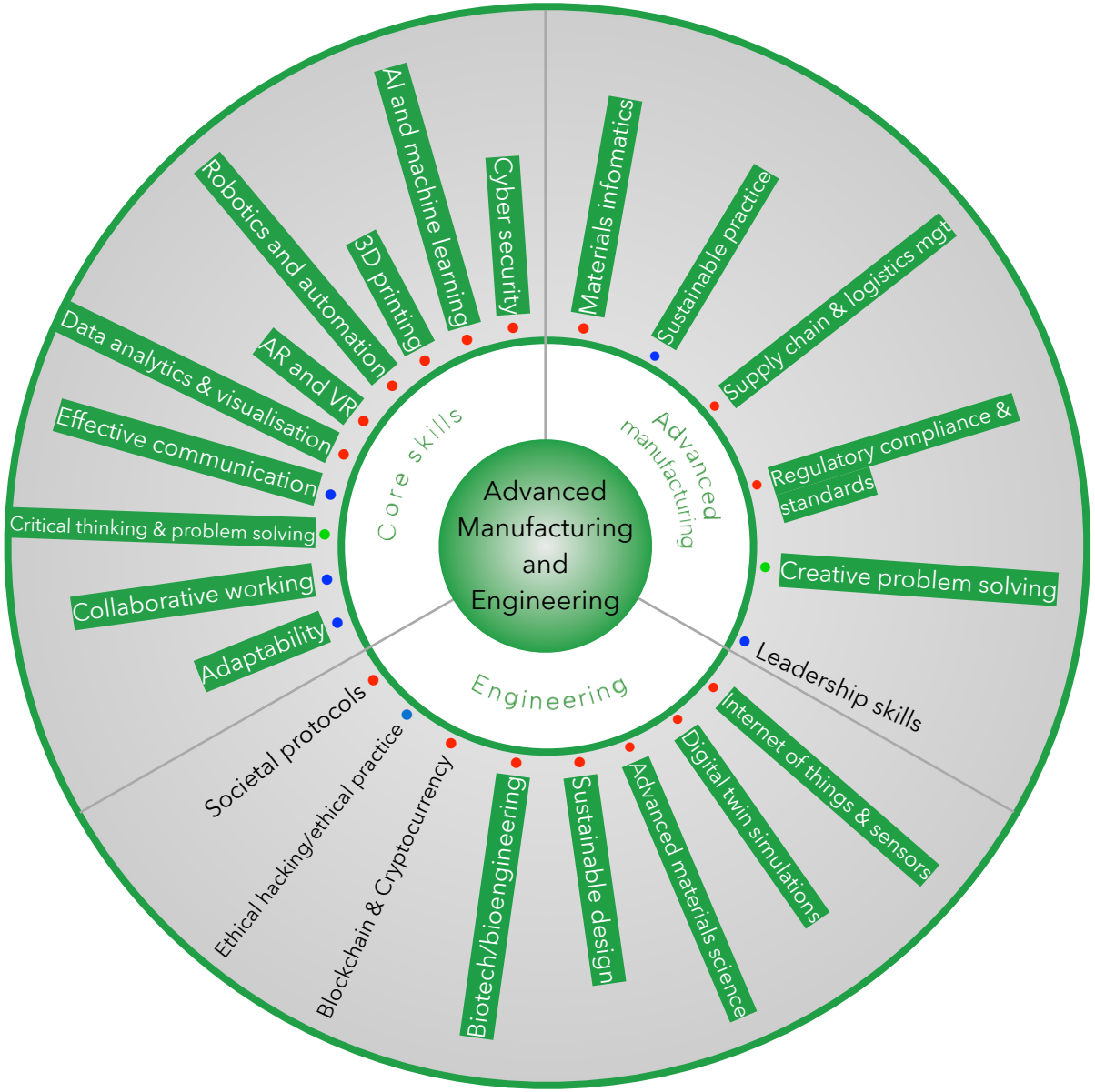
Key skills required to succeed in Net Zero Workplaces



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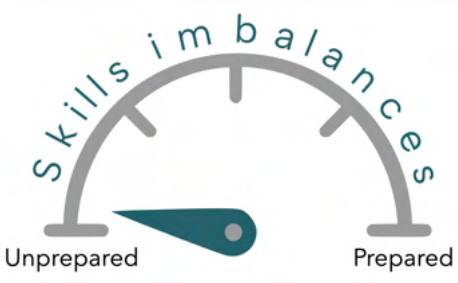
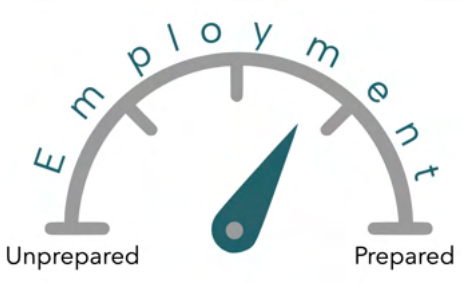
Fit of the 2023 NI skills base with the skills required to succeed in Net Zero Workplaces



NI, like many western economies, does not yet have the skill set it requires to achieve transition to net zero.

That transition is at risk if NI cannot deploy the technologies and technology skills it needs quickly and strategically to drive change in sectors such as agriculture, energy and transport.

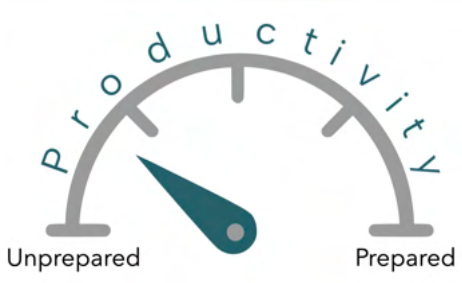
The key to NI's success in this scenario is to buy in those skills - which it can do quickly - rather than wait until it has developed them domestically.



The transition to net zero is likely to create both high tech and non technology jobs.

Success in this scenario will require NI to access skilled labour quickly. Doing so will require it to establish the physical, business and personal infrastructure that will make NI competitive to freelance and tech workers from outside NI.

Creating a strong service economy to achieve this - where jobs are seen as strategic to the region and consequently high value - will create immediate employment opportunities.



Success in this scenario requires boosting productivity through sustained investment in the right technologies and continuous training across the life course in core skills across all key sectors.

Productivity will stay low while businesses transition. While this needs to be closely monitored, government should focus its attention on boosting productivity in the services sector and creating a 24/7 culture.

Government will also need to change its own productivity and ways of working in this scenario.

Mental health and wellbeing are key elements in this scenario and NI should invest in public services that boost it.

The tax take in this scenario is high which means NI is likely to have funds available - even though the cost of transition will be high - and more funding should be put into welfare.

There may be an argument in this scenario for introducing a Universal Basic Income that provides everyone with a base level income. Long term unemployed - and the unemployable - can then be left alone.

Delivering success in Net Zero Workplaces

Position the high tech sector for success

1. **Raise awareness of the business case for change**

   Create a high level, high intensity and widespread business awareness programme to highlight the scale of - and imperative for - change to meet net zero obligations.

   Work with flagship businesses to identify the long-term skills and infrastructure needs

2. **Create opportunities to lead in a niche area of climate change or resilience**

   Identify and focus development on areas where NI has existing capability and other countries also have significant needs - developing components for hydrogen value systems, for example, or driving innovation in the agricultural sector to create net positive practice.

   Prioritise these for investment and support.

   Bring together industry, suppliers and research activities to create a development cluster.

3. **Create a targeted change programme to develop the prioritised areas of the economy**

   Develop and implement a targeted change programme that focusses on priority businesses and areas of the economy. Develop the virtual and physical infrastructure they require to compete successfully.

4. **Identify and implement a distinct value proposition to attract the mobile tech workers that will ensure NI can transition at speed**

   Create a dynamic and supportive environment for SMEs, tech microbusiness and high value tech freelance workers. Strengthen the policy support and technical infrastructure by, for example,

   - writing down training budgets
   - subsidising key enabling infrastructure for remote workers to operate in rural areas
   - creating excellent connectivity and transport access into cities
   - simplifying taxation and reporting procedures for small firms
   - offering marketing and support - including welcome incentives - to attract freelancers to NI

   Explore funding models to support the policy.

Delivering success in Net Zero Workplaces

5. **Post transition, develop a strategic skills development programme with FE and HE**

   Use the development programme to strengthen and sustain the pipeline of tech skills required in the medium to long term. This programme will take a decade or more to come to fruition and policies to support mobile workers will need to remain in place for that time.

Position the high tech sector for success

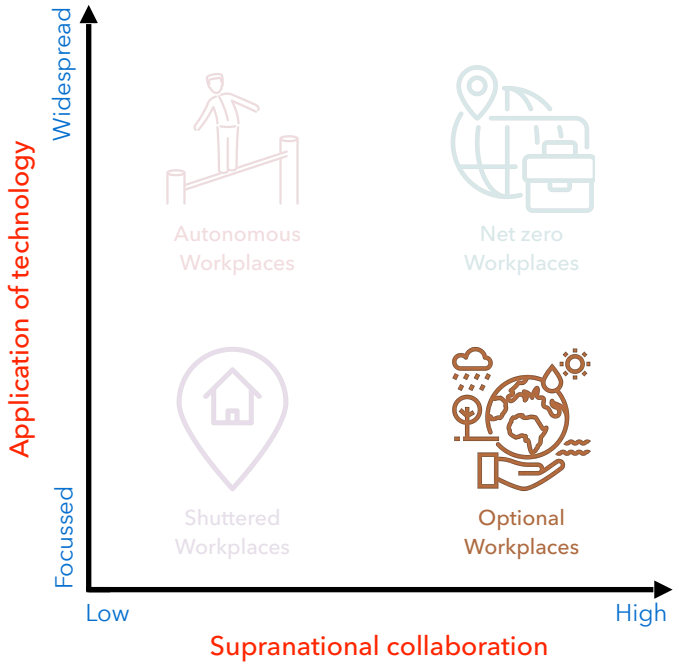
1. **Protect and develop strategic service sectors where virtual-first working is more limited**

   Service sectors - caring, personal services, high level retail - require face to face working. Training and development of staff must be continuous. Staff should be properly remunerated in services that are strategic to future success.

2. **Take a proactive approach to welfare policy to support mental health and wellbeing and to ensure funds are focused on driving change**

3. **Support the private sector to invest in employee skills**

   The private sector will have lower incentives to invest in employee skills due to the rapid turnover of staff and speed of transition - but investment will remain important. The public sector needs to create incentives that supports effective and strategic investment and that builds partnerships with key skilled staff.



Optional Workplaces describes a scenario where the application of technology is focused and supranational collaboration is high.

Economies step back from growth at all costs. Societies and individuals are mainly concerned with achieving societal and personal well-being. Many employees work shorter hours to contribute more to their local communities.

The global situation

The prevailing challenge facing the world is not whether it will adapt to the changing climatic conditions – it will – but whether it can do so without leaving anyone behind.

Governments are committed to a just transition and are working together to deliver it. The path is not easy but the continuing social and economic disruption focusses minds. The number of lives and communities that are destroyed each year by weather events once regarded as unusual - but which are now commonplace - has increased. Such events are no longer restricted to remote places that people only see through their television screens; they now happen closer to home and in places that are much more familiar.

The world's governments have agreed to pool their resources to tackle the shared challenges of climate change. Public investment is narrowly focused on finding workable solutions to low carbon food production, housing, transportation and energy and the big research based economies work on these problems together. Private money is flowing into these areas, too and budgets are comfortable. Progress is positive.

The focus on these issues means that investment in non related tech is limited.

Participating governments have agreed they will share the spoils of success equitably but many are sceptical that will happen.

Those economies sitting outside the collaborative research pool have plenty to get on with while they wait. Cities are undergoing reconstruction to create 20-minute neighbourhoods where most of people's daily needs – work, leisure, retail - can be met within a short walk or cycle. Rural areas are focused on achieving higher productivity in food and renewables production and on reforestation where possible. Building natural capital is key to future success.

These developments are backed up by a tighter regulatory environment which limits carbon emitting behaviours at both the corporate and individual level.

Some economies are inevitably doing better than others and this has caused unrest in parts of the world; others, however, are adapting to a slower pace of life and have adopted circular economy principles – reuse, repair, recycle – extensively. The approach reduces carbon consumption (of course) but it has also (and unexpectedly) strengthened social infrastructure and built more purposeful, actively engaged communities.

Continued degradation of the natural environment means that many once productive rural and coastal communities around the world are facing decline. This continues to be a significant global problem that is displacing increasing numbers of people.

The Northern Ireland economy

Growth in Northern Ireland is low but employment is high. This apparent paradox is due to the increased economic activity in the region, but the relatively low skill level of the jobs – which means there is a high level of underemployment. NI, like many economies that are making a limited contribution to the development of climate change solutions, has less high tech and high skill jobs available but plenty of work for those who want it.

With a global oversupply of talent at the moment, many are happy to take any work that is going.

NI is busy retrofitting its old building stock and redesigning its urban centres to meet the 20-minute neighbourhood (20MN) standard. These developments mean that residents can meet the majority of their day-to-day needs - shopping, leisure, access to schools, local services such as a GP practice and access to work - within a 20 minute walk or cycle from their home.

Each neighbourhood has some affordable housing and is designed so that residents have access to quality public transport that connects them to jobs and higher-order services. The new urban design and (re) construction is labour intensive. Engineering skills are in high demand.

There are some concerns that the urban focus of 20MNs is set to disadvantage rural areas and government is drawing up options to ensure this is not the case.

The 20MN programme is ambitious and is soaking up what little public funds are available for technology. This means there is no money for investment outside those areas where NI is contributing to the global research effort – a contribution that is tightly managed by the UK government and targeted on a few strategic technologies. In NI, these are in precision and sustainable agriculture and in precision medicine and diagnostics. R&D in fintech, advanced engineering and digital/ICT are practically non-existent.

There is, however, a big push to deploy ICT across both public and private sectors to improve efficiency and productivity. These activities are managed by government. AI, for example, is tightly regulated and used primarily for improvements in environmental monitoring, delivering more efficient public transport, and ensuring fairer prioritisation and allocation of resources.

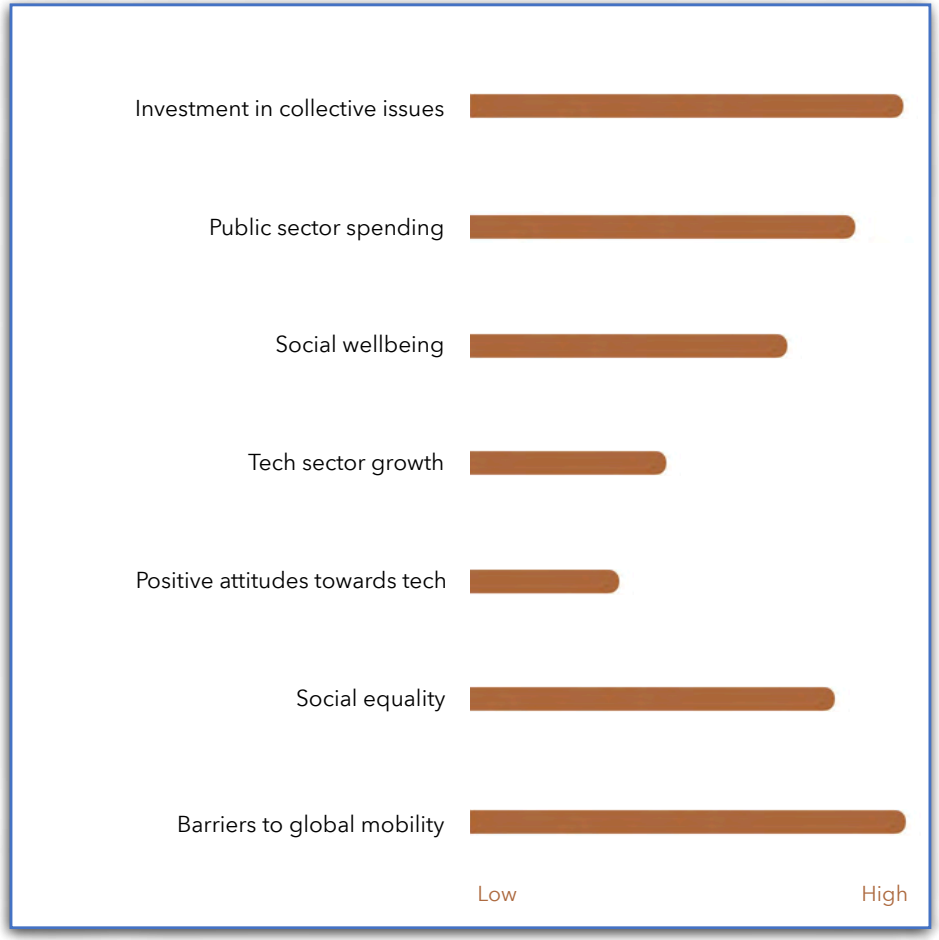
The concept of ownership is changing fundamentally. Consumers make do and mend far more now than in the recent past, primarily to save money. People are much more interested in the environmental benefits of leasing or sharing goods and local exchange trading schemes (LETS) - skills sharing platforms which promote informal exchange of services paid for by barter - have proliferated in communities across NI.

This is a world of regional levelling down but, perhaps surprisingly, NI's citizens are happy to accept low growth because they can see it is a necessary condition to achieve the greater global good of improving planetary health. Overall, there has been a significant cultural shift which means that many employees work shorter hours and spend significantly more time contributing to their (strengthening) local communities. Some, of course, find levelling down difficult and continue to struggle with a sense of lost opportunity and purpose.

Citizens can see that government is trying hard to look after the less well off in society. The welfare system has been reformed and universal basic income is available to that segment of the population that is unable to reskill. Managing this effectively is tricky – there are plenty who want into the system and plenty who fall through the cracks – but high employment means the overall social security bill is down.

Key characteristics of Optional Workplaces

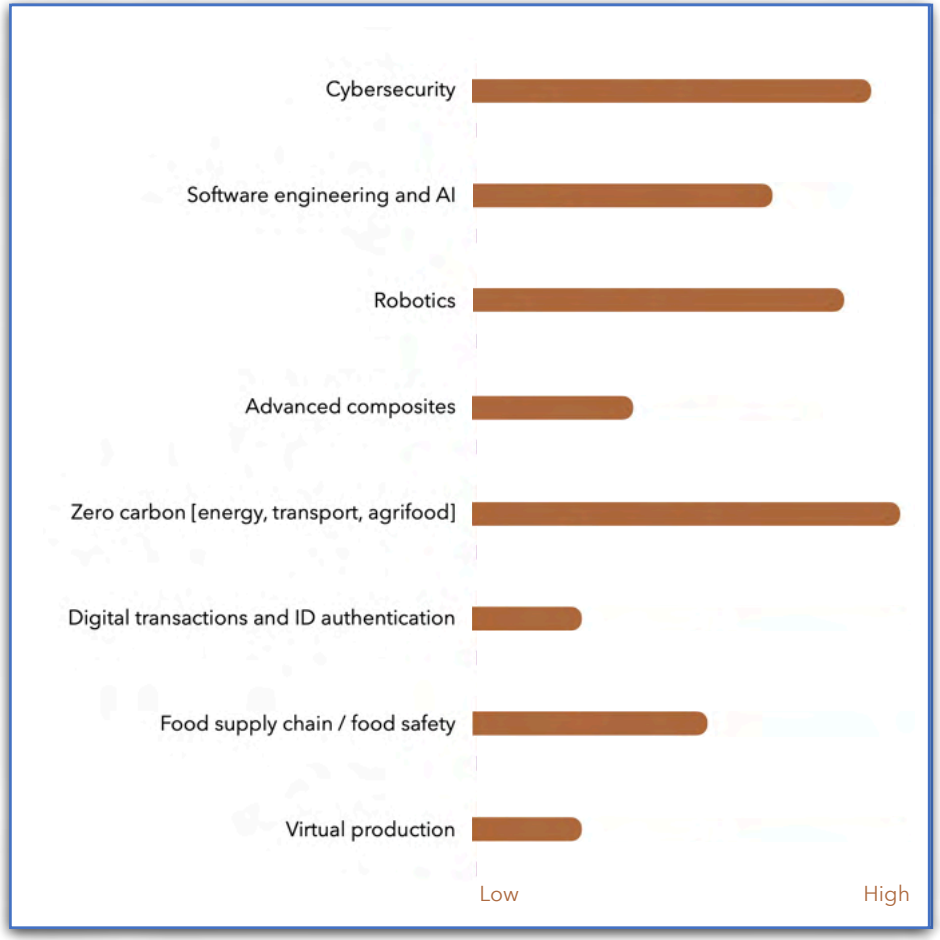
Key scenario features



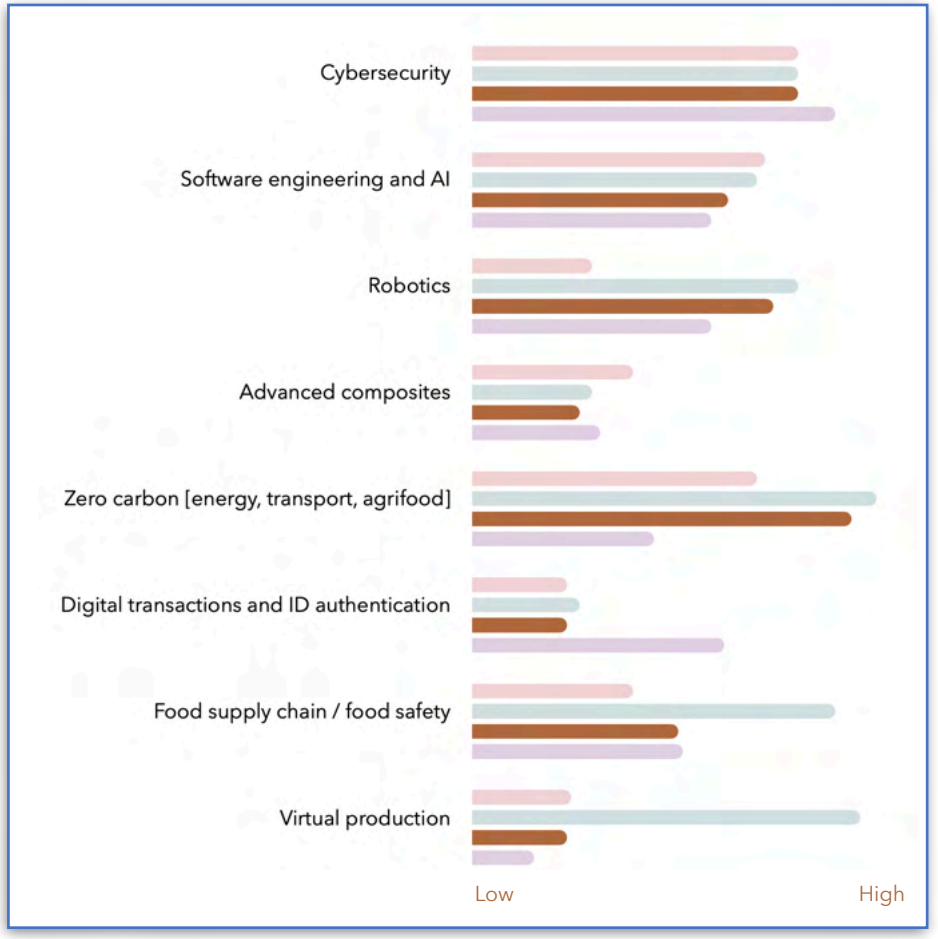
Comparison of key scenario features

Key characteristics of Optional Workplaces

Prominence of key technologies



Comparison of key technologies across the scenarios



Prominent technologies

Embedded IoT sensors and data analytics for real-time monitoring of energy usage, traffic patterns and other urban metrics, enabling better resource management

Construction and retrofitting of buildings to be highly energy efficient

Centralising energy production and distribution using smart grids and deploying heat pumps and waste heat from industrial processes

Establishing EV charging infrastructure and electrifying all public transportation

Designing pedestrian-friendly and bike-friendly infrastructure

Using sustainable and locally sourced building materials with low carbon footprint

Data driven decision making using data analytics to improve service design, target policy interventions and focus resource allocation

IOT and data analytics for real time monitoring and management of (for example) transportation, energy use and waste management

Digital delivery of public services such as tax filing, voter registration, social welfare applications. Collection of citizen data enables personalised service delivery

Digital identity authentication to provide secure digital identity systems

Omics to understand disease mechanisms and deliver personalised treatments

Remote patient monitoring through wearable devices and telehealth platforms

Data Integration of, for example, electronic health records, genomics data and wearables to design personalised treatments and disease prevention strategies

Data collection on soil and crop conditions to optimise planting, irrigation, fertilisation and pest management

Vertical Farming, growing crops in stacked layers indoors using controlled environments

Commentary

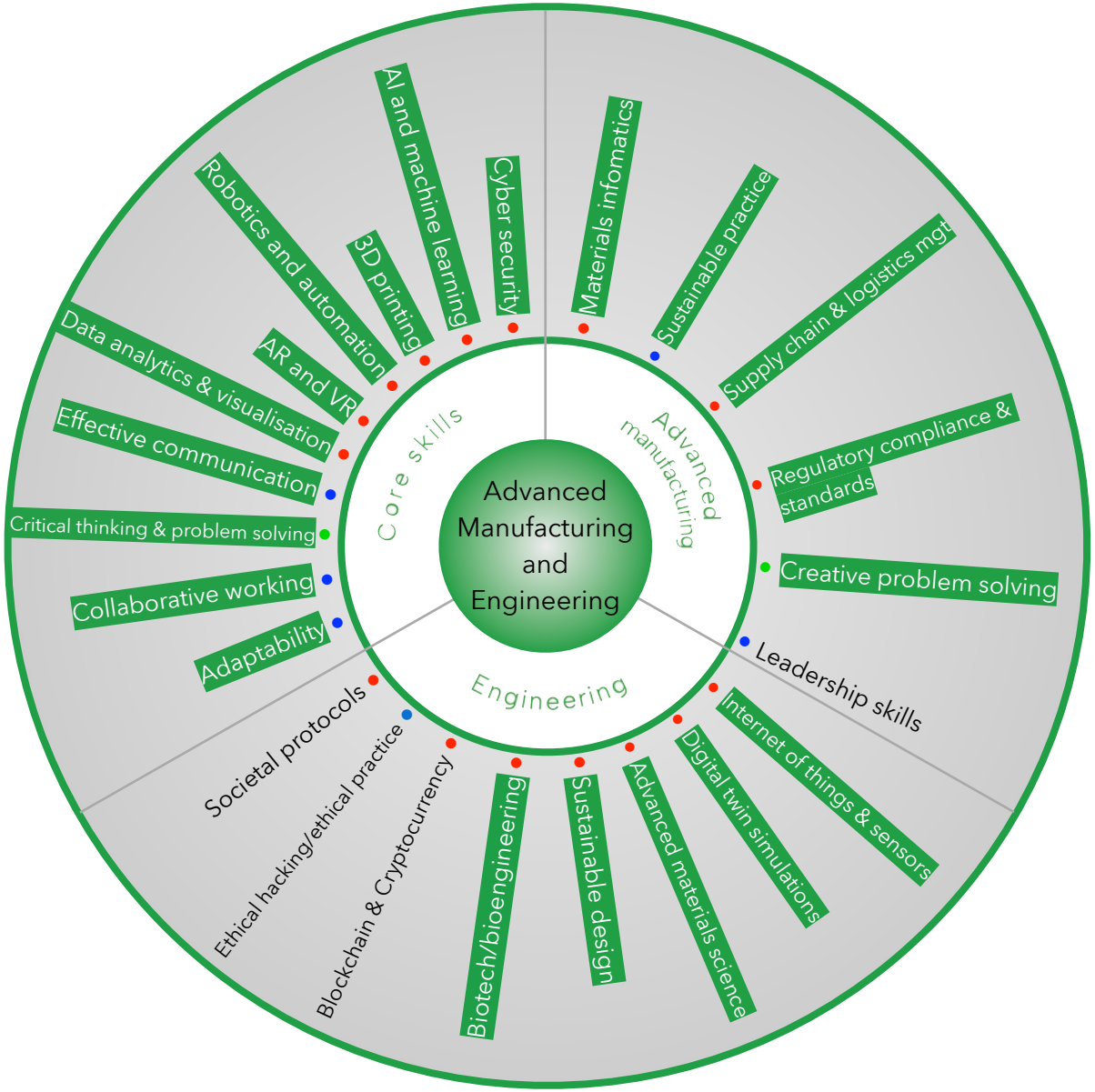
Advanced Manufacturing and Engineering is the most prominent cluster due to the extensive redevelopment of NI's urban centres. Engineering skills are in demand - but advanced manufacturing skills are not. Like other technologies, it is concentrated in the global research effort.

The deployment of ICT is focused on the application and maintenance of systems rather than on their development, which reduces the importance of other skills in the Digital, ICT and Creative Industries clusters. The same is true in Life and Health Sciences.

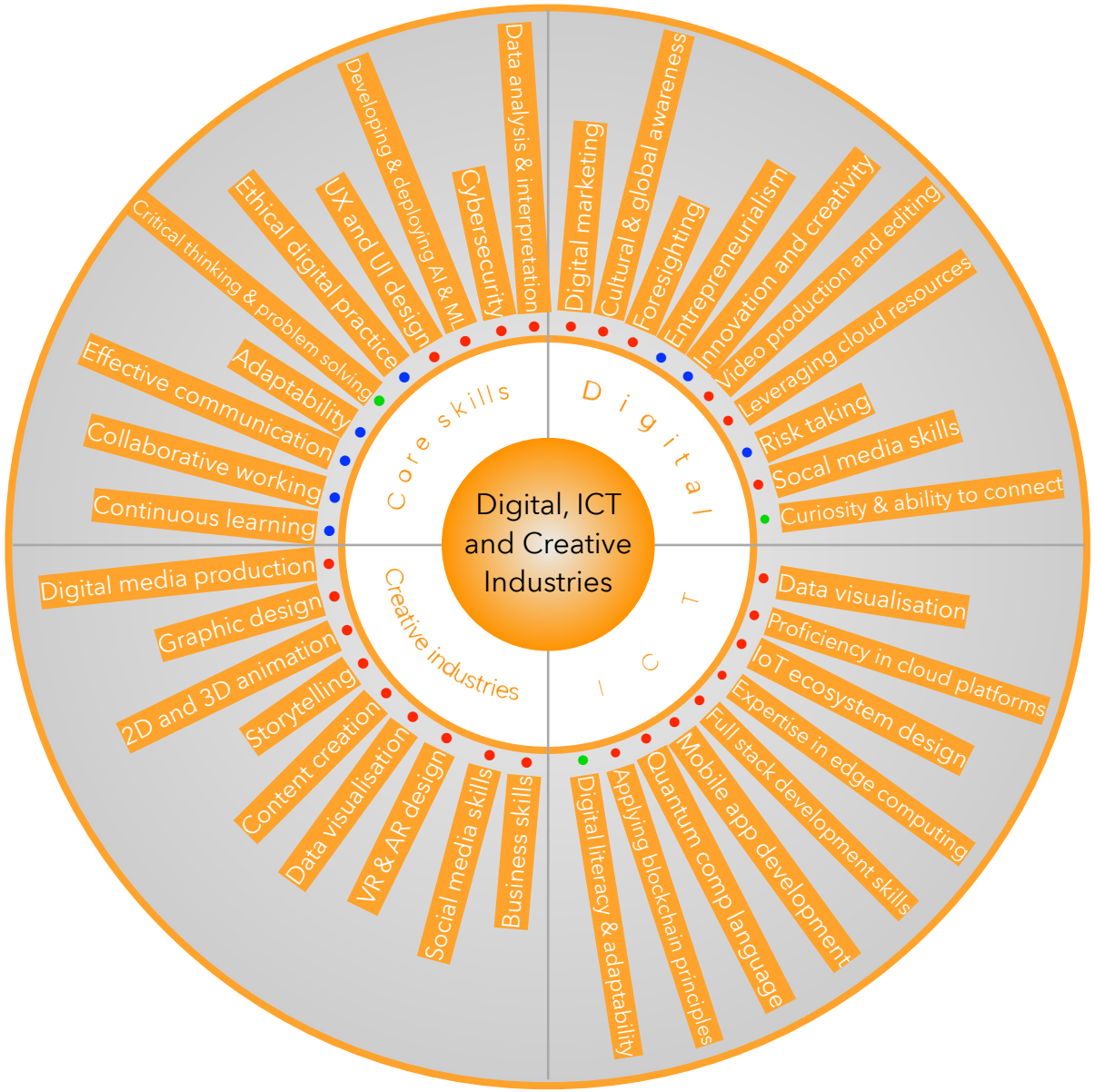
Agriculture is important, of course, but the skills base is reduced. Here, too, it is the application of technology that is key to success.

One strategic consequence of this scenario is that NI will - at some point in the late 2030s or early 2040s - have access to the technologies that are being developed at the global level. Applying those technologies to mitigate the impacts of climate change and to help NI adapt to its consequences will require skills that NI will likely have reduced investment in. NI will therefore need a strategic approach to rapid skills development or, perhaps - as in *Net Zero Workplaces* - to buying in the right skills at the right time. In this scenario, such skilled workers will be appointed to public delivery bodies or directly to the private sector. They will not be freelance workers.

Key skills required to succeed in Optional Workplaces



Key skills required to succeed in Optional Workplaces



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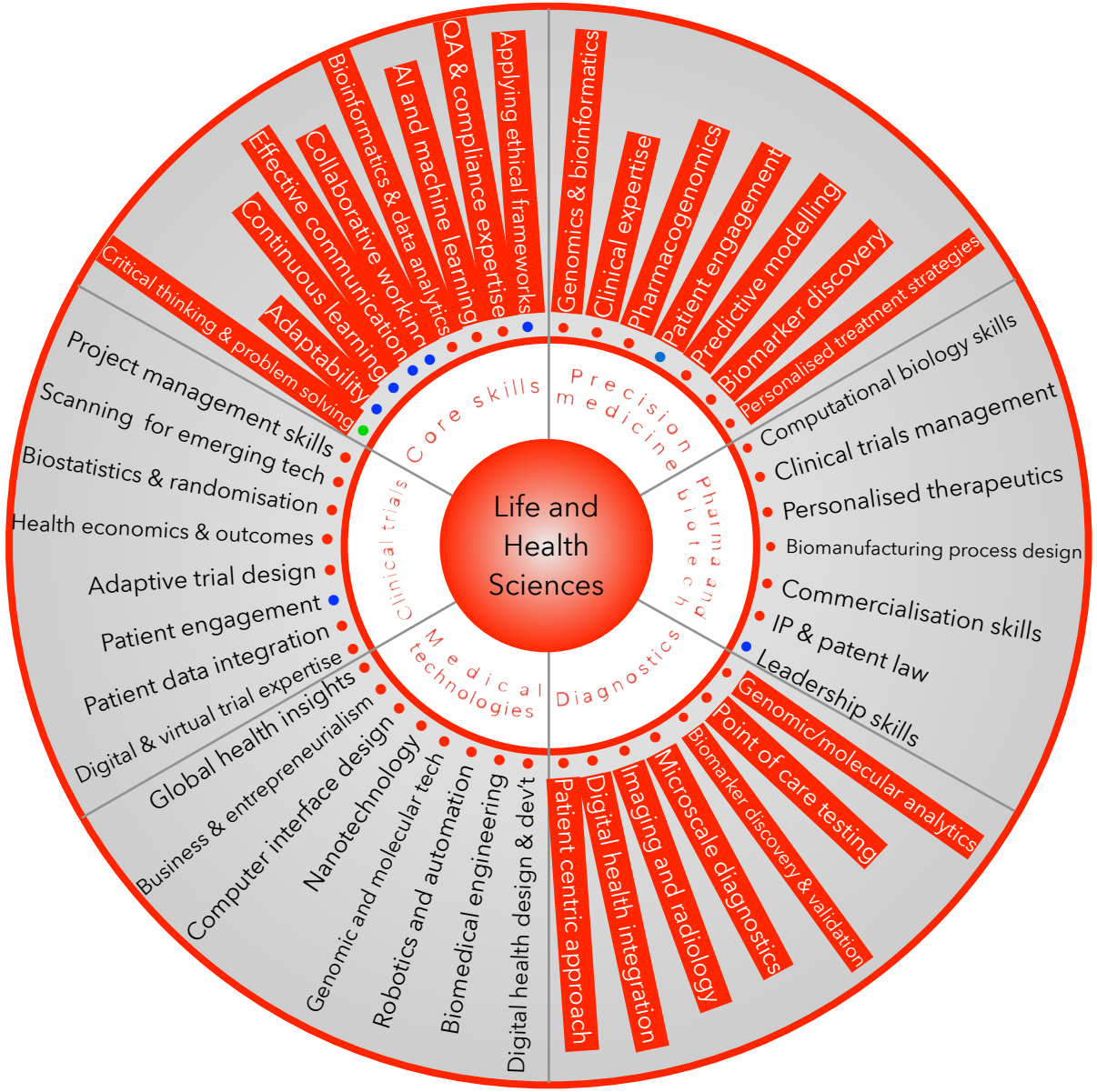
Key skills required to succeed in Optional Workplaces



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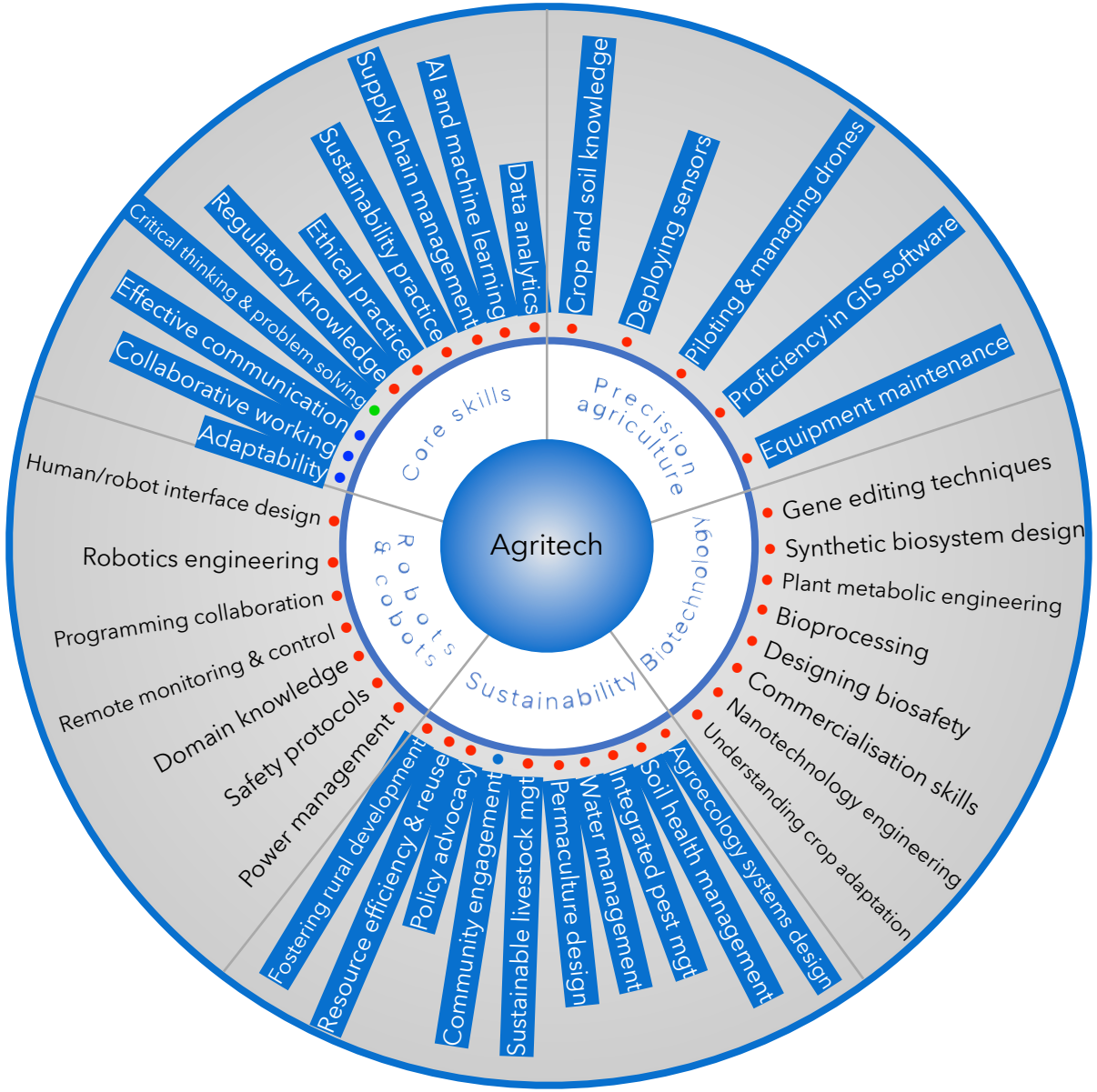
Key skills required to succeed in Optional Workplaces



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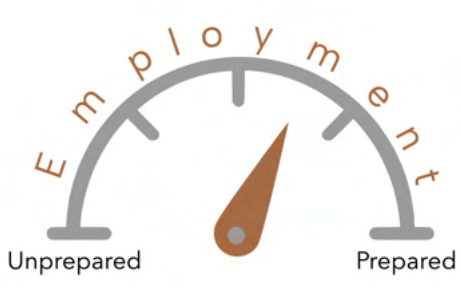
Fit of the 2023 NI skills base with the skills required to succeed in Optional Workplaces

The relatively low skill levels required for success in this scenario mean that NI is reasonably well placed to have the skills it needs.

This does not mean the skills are extant. NI must ensure it has the infrastructure and capacity it needs to deliver the full range of skills in time to deploy them.

A potential challenge is that some parts of the labour force may need encouragement to take on these lower skilled jobs in the early stages of the scenario.



The scenario is likely to create a high number of full-time equivalent jobs, albeit low skilled ones. The pace and scale of development required to create 20 minute neighbourhoods means that shift working - two or even three shifts in a 24 hour period - will be prevalent.

These jobs will be shared out in this scenario. Most employees want to leave work at the end of eight hours and spend additional time building up their communities through formal or informal activities.

Boosting productivity will be important in this scenario. Here, the skilful and appropriate deployment of technology will be key.

This may require substantial training and development, even of lower level skillsets. Application of technology will improve the efficiency and effectiveness of some routine tasks, freeing workers to upskill and to boost productivity.

Effective management will be a critical skill in this scenario and one that will be key to achieving productivity gains.

High employment means the welfare bill is down in the scenario. One outcome from levelling down - the matching of overly skilled workers to lower skill jobs - is particularly important in reducing the bill.

This has enabled reform of the welfare system. Universal basic income is available to that segment of the population that is unable to reskill.

Managing this is tricky – there are plenty who want into the system and plenty who fall through the cracks – but government is committed to sustaining the reforms.

Delivering success in Optional Workplaces

Position the high tech sector for success

1. **Use public infrastructure investment to drive jobs growth**

   Major investment in public infrastructure projects creates local low carbon neighbourhoods and develops connectivity and green energy infrastructure.

   Engineering skills are in high demand.

   Projects are managed in a long-term fashion to grow locally-headquartered firms and upskill locally based workforces, with a vision for managed transitions to other local industries or exporting after the projects are completed.

2. **Position NI as a top location to deploy Tech for Good**

   Capitalising on the population's desire to build and give something back to their communities, NI can become a Tech for Good hub, deploying innovation to deliver community cohesion.

   - Online platforms and social media enable community members to connect, share information, and organise events. This enhances community engagement, facilitates discussions about local issues, and fosters a sense of belonging.
   - Communities monitor local environmental conditions to promote and encourage sustainable practices. Smart meters, sensor networks, and data analytics help communities manage water and energy more efficiently.
   - Local government uses technology to improve the delivery of public services. Online portals and apps streamline processes for obtaining permits, paying taxes, and accessing important documents.

3. **Government and private sector work closely together to develop a strategic approach to long term skills development**

   NI needs to prepare to apply the technologies being developed at the global level to mitigate the impacts of climate change. This will require skills that NI has reduced investment in - and ones which businesses have limited spending power to develop. Government and business will need to agree a joint strategic approach to rapid skills development or buying in the right skills at the right time.

Delivering success in Optional Workplaces

Options for investing in skills systems to support tech

1. **Increase investment in engineering and ICT skills**

   Ensure that technology skills training is not spread too widely. Focus on the strategic skills in this scenario - engineering, ICT and certain life sciences and agritech skills - and manage supply in these areas.

   Ensure skills curricula are practically oriented.

2. **Support those formerly employed in high tech sectors to redeploy or refresh their skills**

   Some workers in former high tech sectors will need to retrain if job opportunities disappear to a common global research programme. They should be supported to retrain.

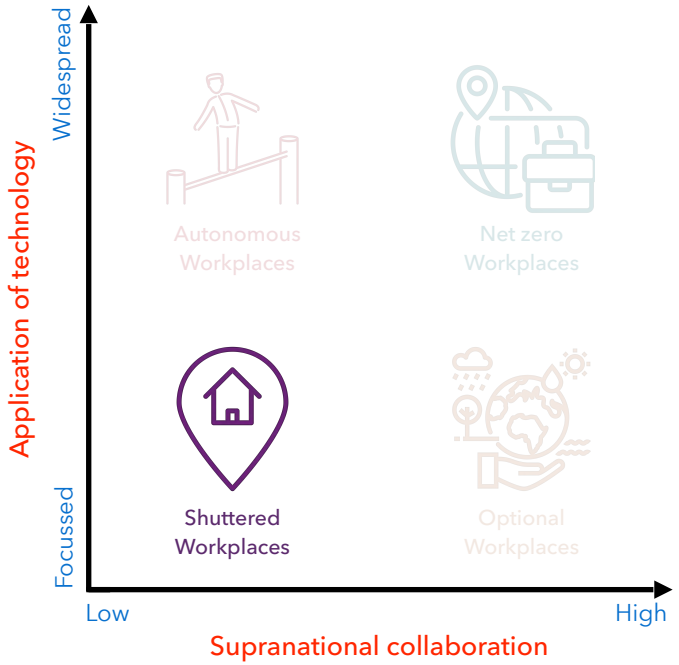
   These workers will have a significant contribution to make to their communities, acting as designers, builders and maintainers of the community infrastructures that are developed in this scenario.

   Government should focus skills funding and investment on supporting these community initiatives which will provide the societal glue that will be important to success in this scenario.

   More broadly, unemployment services should focus more on life coaching and personal development, signposting people to direct skills training and self-directed learning options.

3. **Increase formal education in active citizenship**

   Emphasise the importance of community values and ways to contribute within different community structures, helping young people think about the types of communities available for them to join after graduation.



Shuttered Workplaces describes a scenario where the application of technology is focused and supranational collaboration is low.

The global balance of economic and political power has shifted towards China and the southern hemisphere. Continued cycles of recession in the west and lowered trust in governments and corporates make it hard to keep up.

The global situation

10 years (and more) of failing to agree how to tackle the existential crises facing the global economy have taken their toll. A succession of climate change treaties have proved too challenging to implement. Governments have chosen, instead, to kick the can down the road. The sustained global recession that followed the Covid-19 pandemic has seen unemployment rise, national debt reach eye watering levels and public services decline. Consumers in the west have chosen not to change behaviours in the face of climate change and governments, forever with an eye on re-election, have chosen to let them.

Many governments do not trust each other either. The continuing wars in Europe and Africa are destabilising and have become a proxy for direct conflict between the superpowers as each funds their own side.

Citizens do not trust their own governments or institutions and society has been overcome by a post pandemic paranoia that big brother is always watching and manipulating their choices. Concerns over privacy have led to a backlash against big tech in all its guises. Communities have become divided and factionalised as growing numbers of pressure groups call out perceived biases, demand equality and shout over the top of each other.

For some, however, these are 'old world concerns' that mainly affect the west and north. The 'new world' – the power bloc that lies in the east and south of the globe and is led by China – is on the ascendant.

One reason the west chose not to do much about climate change was, it said, because China was the main culprit and needed to address its carbon emissions. Now, China and its allies are changing rapidly - and they own the technologies that make change happen and that support adaptation. They also control the supply of minerals and precious metals needed to support alternative fuel technologies. However uncomfortable the truth may be, the world's new leading superpower has the political processes in place to drive change rapidly.

The Chinese bloc poses more than an economic challenge to the west. China and its allies have spent the last decade and more extending their reach into the world's virtual and physical security infrastructure. They do not control it completely, but they have various switches they can flip to cause turbulence. That they don't do so more often is down to the west's ability to do the same back – so all sides continue to manoeuvre cautiously around each other as they monitor security breaches.

The key challenge for the west as it tries to respond to China's rise is that it needs to move quickly. Doing so will require businesses to form new partnerships, to trust legislators again and to take risks.

It's a big ask.

The Northern Ireland economy

Northern Ireland has suffered the same consumer backlash against technology that has affected other economies and consumer tech sectors have declined as a result. Many employers have closed and former employees have moved offshore.

Government has, however, continued to support those strategic sectors – communication infrastructure, defence and cybersecurity - that are essential for the UK's security. Performance has not been stellar and getting back to full capacity has required a significant injection of public funding.

Initial support from the UK government was essential to give NI a leg up and came with the condition that it was used to build up cybersecurity and defence AI - both key for national security. Funding has been directed towards FE and HE to strengthen the curriculum.

Government has directed the education institutions to work closely with them and the sector to ensure that education is up to date and that students are work ready when they leave their courses. The requirement for rapid scale up has meant buying in teaching capacity.

A growing number of businesses are actively involved in course design and an increasing number of students are studying through a blended model that encompasses work, day release (in NI) and online classes (some of them delivered by technical universities in partner nations as part of a reciprocal arrangement). It's an innovative approach that is yielding benefits – but significant concerns remain about the number of pupils leaving school without the necessary foundational skills.

It seems that NI will need to look beyond its borders to recruit workers for some time to come. Government is very aware of the need to do so and is committed to act.

It looks like hardware and manufacturing might grow in the near future but achieving this will require walking a tightrope between providing enough public sector investment to make NI attractive and keeping that investment relatively low key.

None of this is easy against an international backdrop of uncertainty and falling trust ratings at home. Here, NI is no different from other parts of the western bloc - society remains sceptical of both

government and the private sector and continues to see public interventions as diverting money away from the communities and places that really need it.

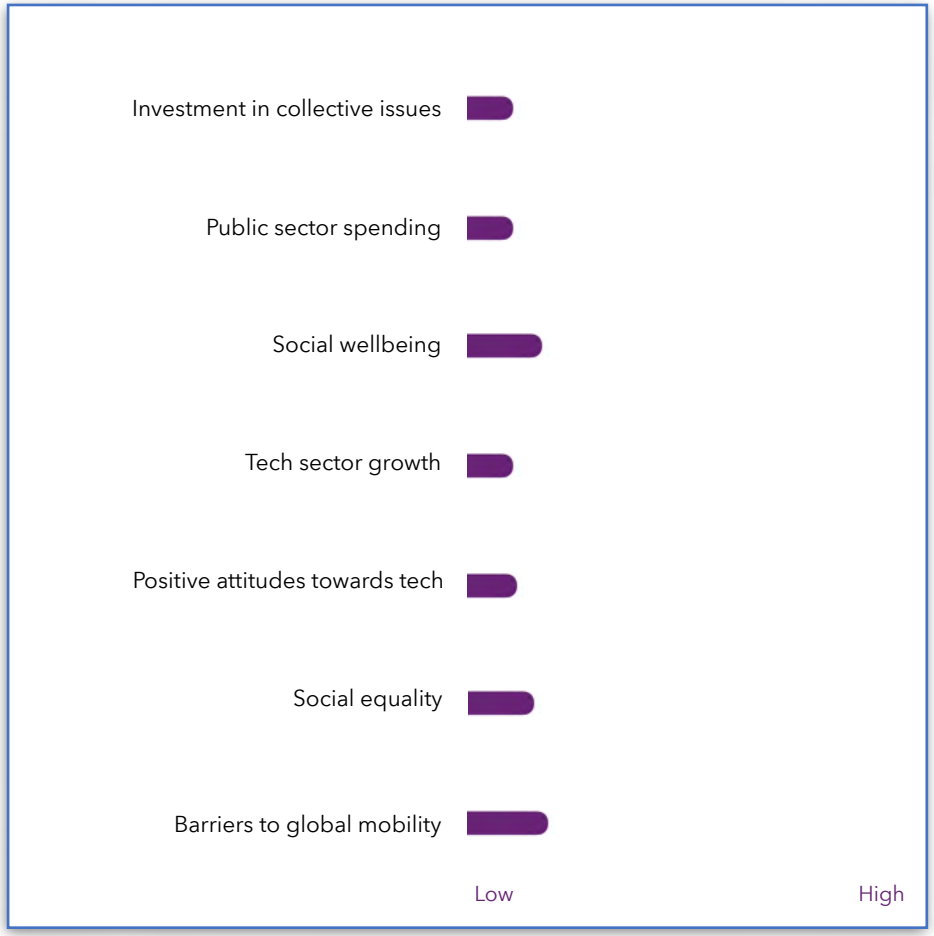
The absence of trust makes it difficult for citizens to see the genuine efforts that governments are making and reinforces their (unfounded) opinions that businesses are only interested in making a fast buck. Neither of these is the truth. The uncomfortable reality is that China's rise is creating unprecedented turbulence in the global economy as the eastern bloc tightens its grip on markets and supply chains. The private sector in particular is simply trying as hard as it can to find a foothold and to build up its local supply chains - but constantly changing technologies, markets and skill needs make the task anything but simple.

These are inconvenient truths for society and most citizens choose to ignore them. Sadly, it sometimes seems that NI's citizens are raising their voice so loudly to complain that they are simply not hearing the growing warnings about the wider economic and political threats that are challenging future prosperity. Worse, it seems that government is in danger of spending too much time trying to persuade them otherwise - and not enough trying to steer the economy into calmer waters.

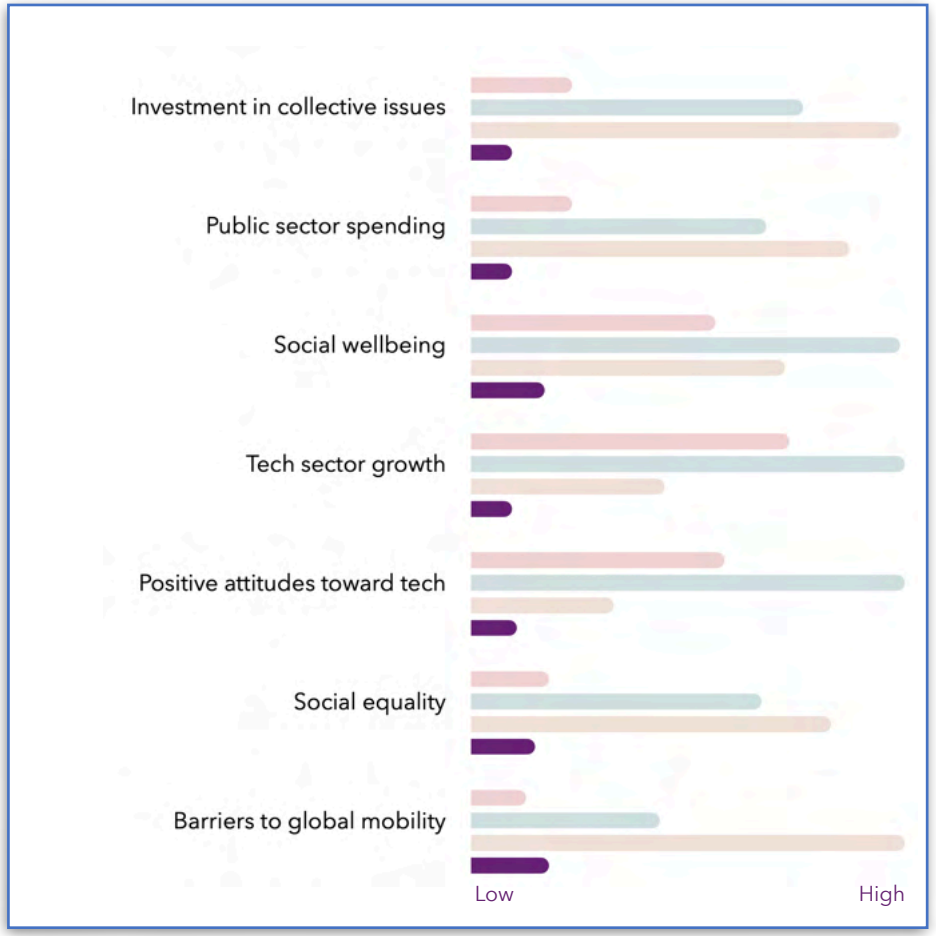
The concern is that, like one of its most famous ships, NI doesn't realise it is sailing towards disaster. By the time it does, it may well be too late to take avoiding action.

Key characteristics of Shuttered Workplaces

Key scenario features

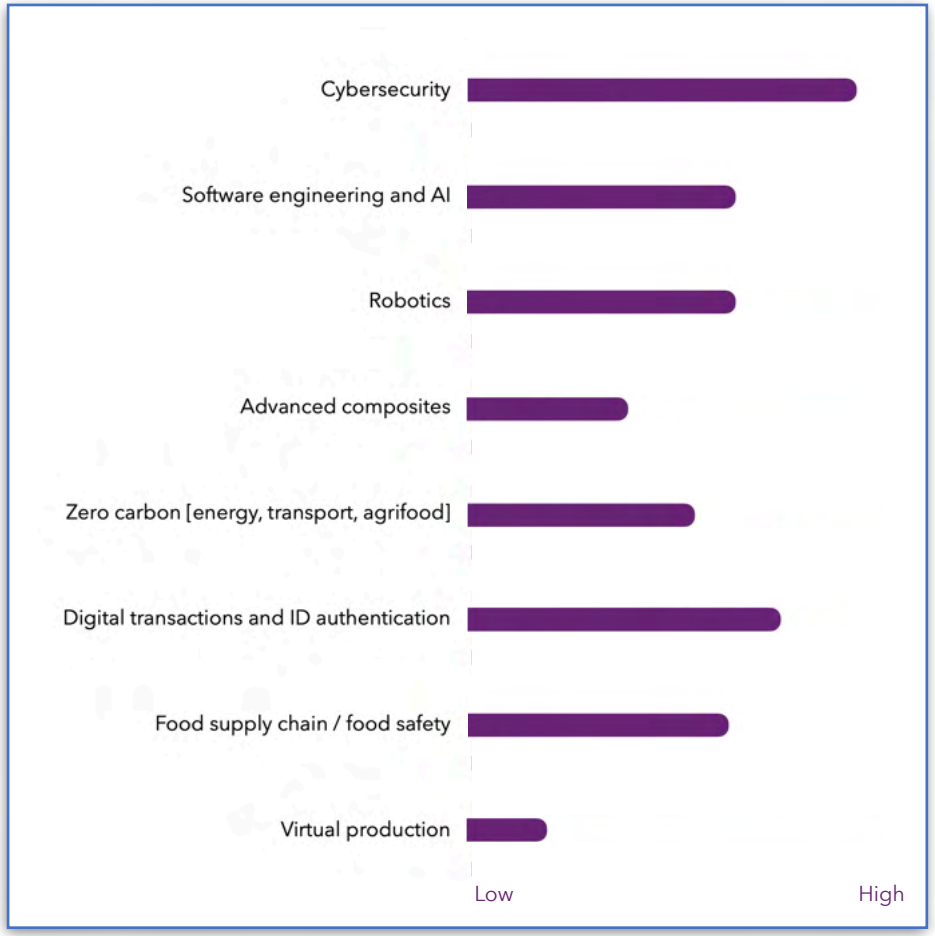


Comparison of key scenario features

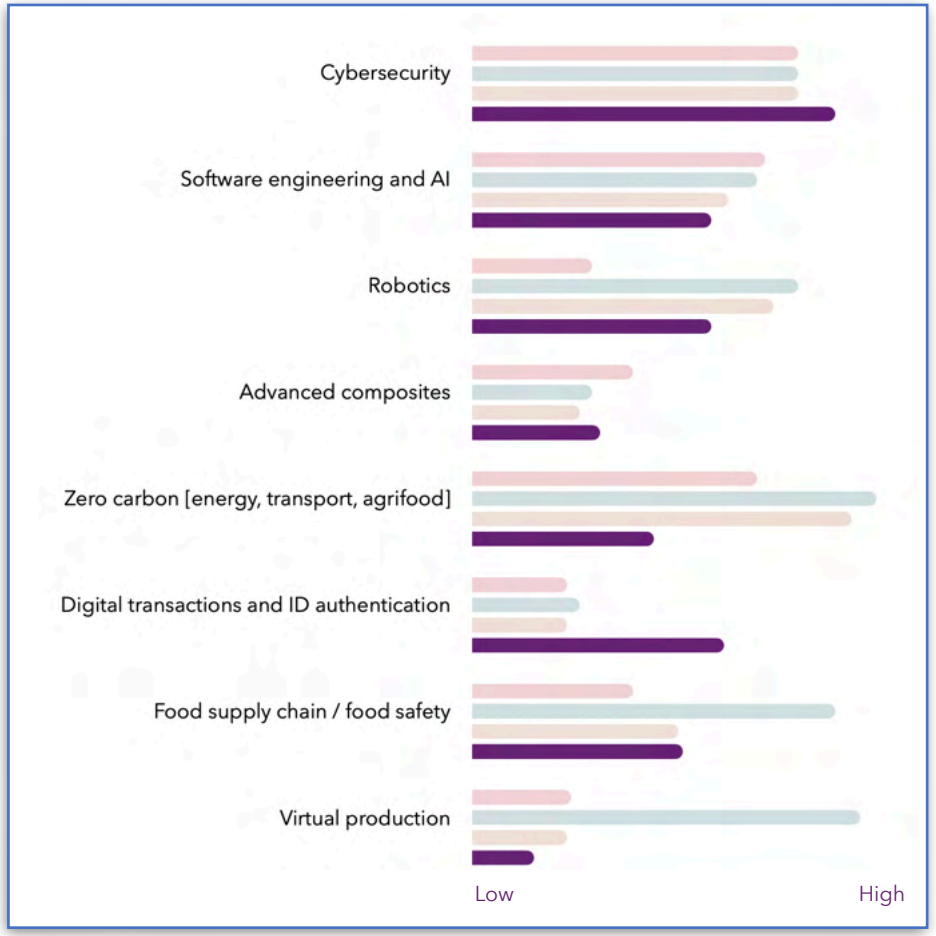


Key characteristics of Shuttered Workplaces

Prominence of key technologies



Comparison of key technologies across the scenarios



Prominent technologies

Digital, ICT and Creative Industries

Secure networks and data encryption to transmit classified information and data that are resilient against cyberattacks and unauthorised access

Advanced Sensors, including radar and surveillance, to build comprehensive digital mapping and real time monitoring of the operational environment

Autonomous Systems to support unmanned drones, ground vehicles and naval vessels - remote surveillance, reconnaissance and data collection

Predictive Maintenance, using AI to monitor equipment and machinery remotely and to carry out remote repairs and maintenance in advance of need

Cybersecurity, detecting unusual patterns in network traffic, flagging security breaches and initiating automated protective countermeasures

Predictive Modelling of crime and criminal behaviours

Advanced Manufacturing & Engineering

Integrating robotics, cobotics and predictive analytics into supply chain management to reduce lead times, increase efficiency, and improve overall logistics processes

3D printing and rapid manufacturing to secure supply chains through localised prototyping, production and customisation

Fintech/ Financial Services

Cybersecurity including firewalls, intrusion detection/prevention systems and encryption technologies to safeguard sensitive data.

Applying biometrics to enhance security of cryptocurrency wallets and exchanges

Applying effective encryption to protect customer information and financial data from unauthorised access

Agritech

Deploying intelligent agriculture solutions by applying sensors/data analytics/ internet of things technologies across all stages of the food chain

Life and Health Sciences

Commentary

This scenario demands resilience, inventiveness and a dogged approach to continuous improvement. There are no opportunities to rest on laurels for economies that seek to be successful.

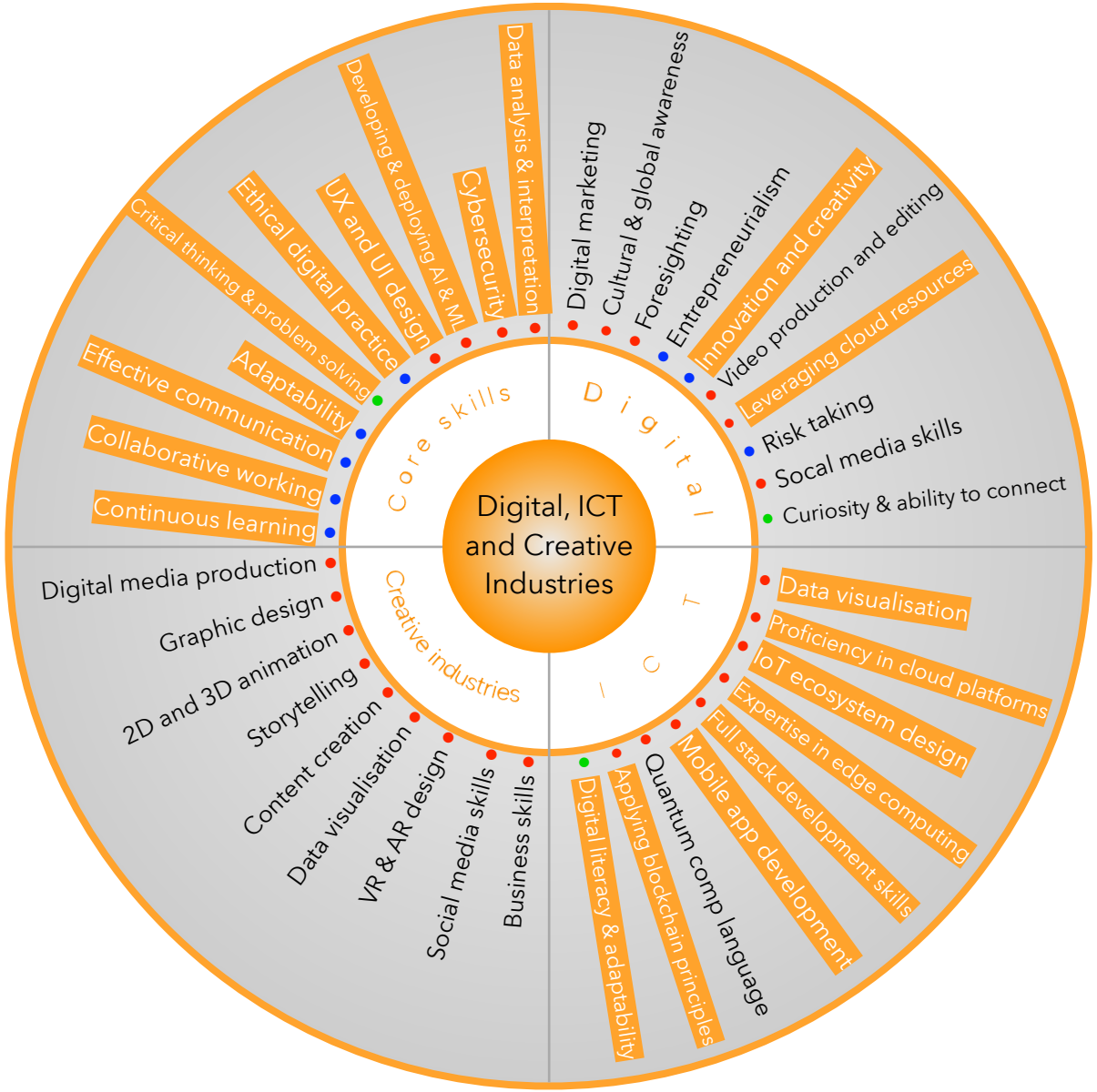
Tech development is largely driven by niche activities in the defence and security sectors and by the private sector's need to shorten supply chains and control supply.

NI will be more successful if it collaborates across multinational supply chains. Markets are likely to dry up quickly if it does not. Establishing clear blue water strategies - but being willing to adapt and flex quickly - will be key.

Adaptability will be an entry level requirement for business and for individuals - and the pressure to adapt continuously will be stronger in this scenario than in others.

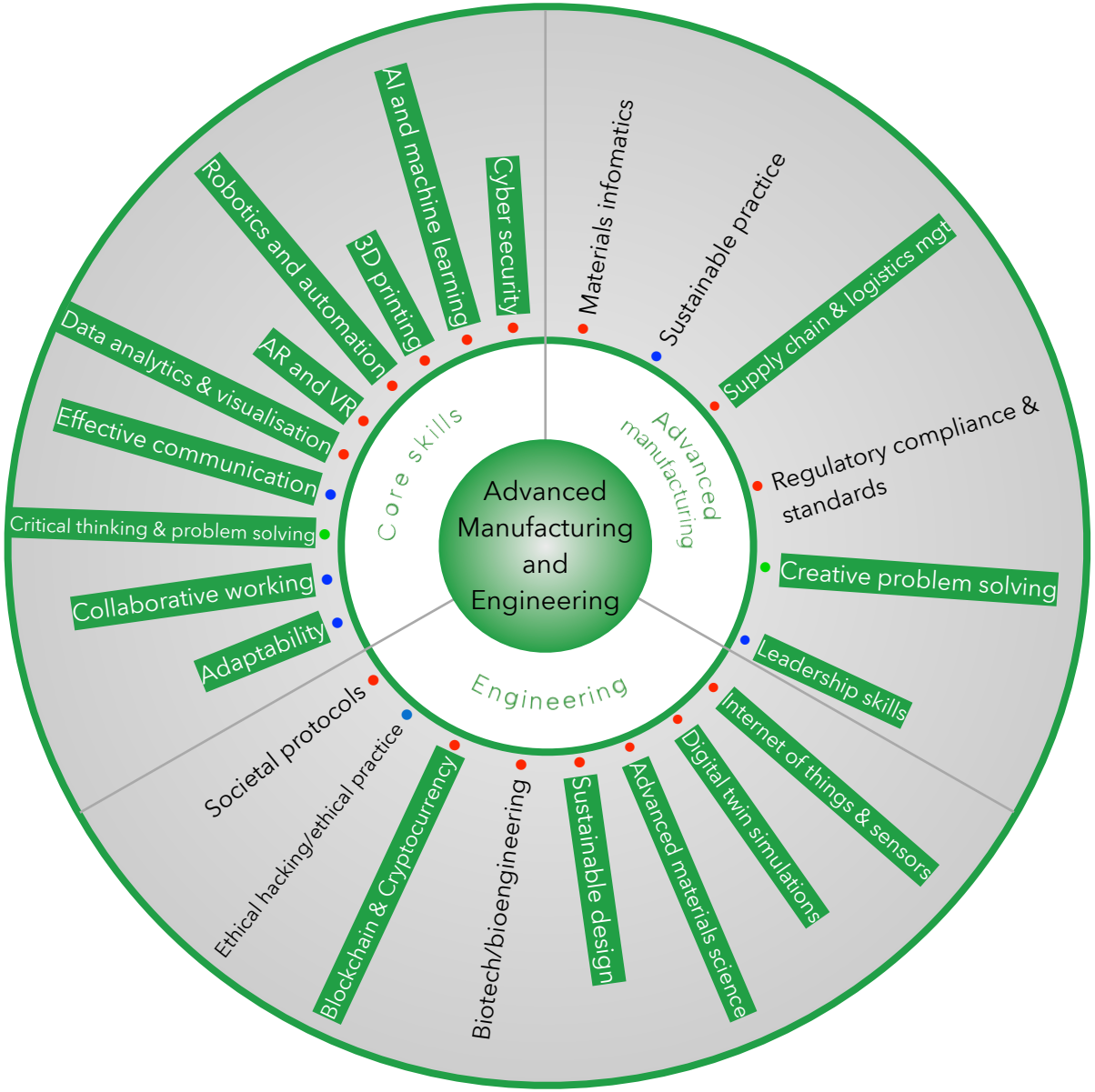
Of all the scenarios, then, this one perhaps demands the greatest cultural shift in NI's business base. And, perhaps, failing to achieve that cultural shift is a greater threat to future prosperity in NI than in any other scenario.

Key skills required to succeed in Shuttered Workplaces



The scenarios are not predictions, projections or an assessment of current government policy

Key skills required to succeed in Shuttered Workplaces



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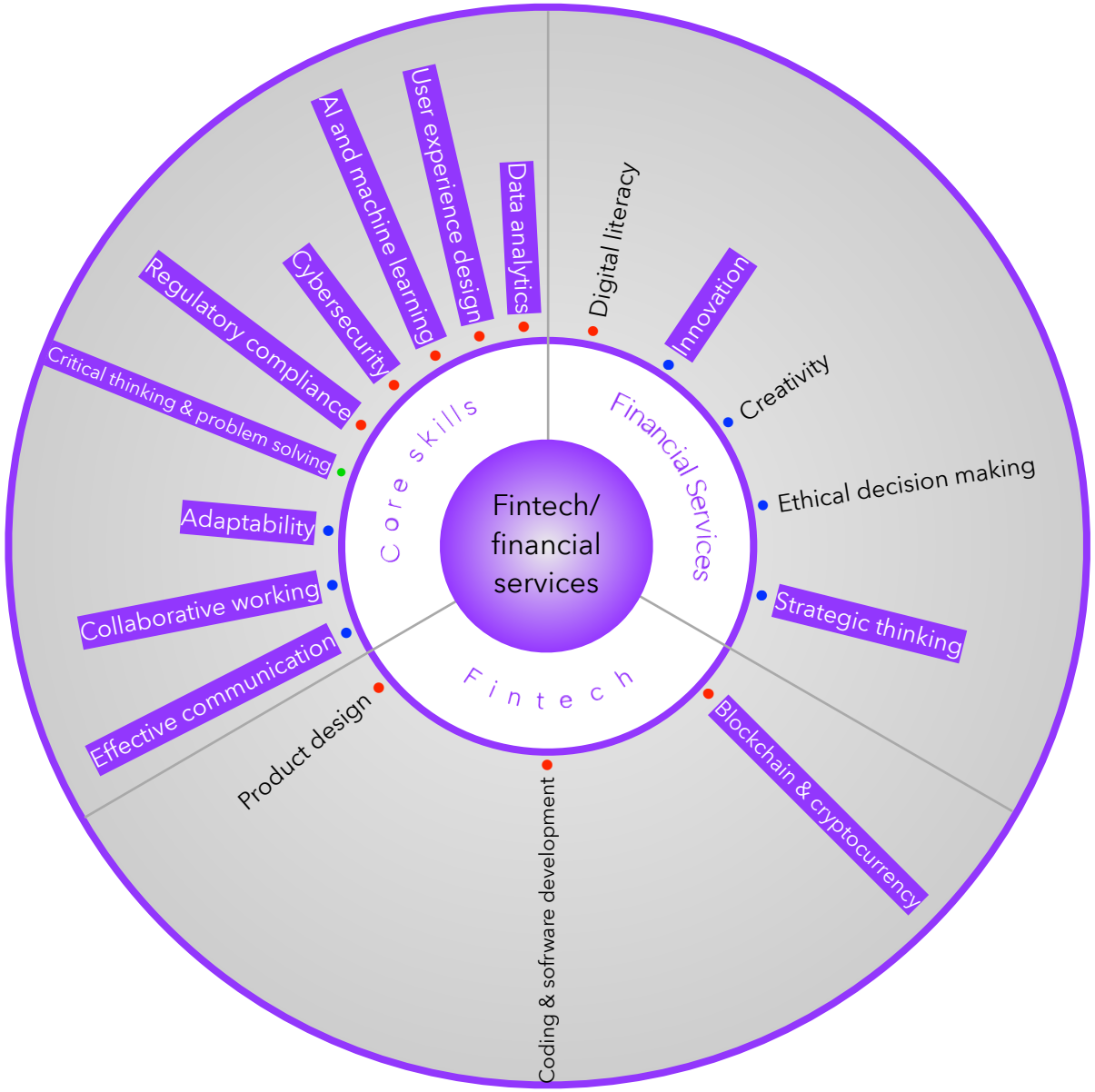
Key skills required to succeed in Shuttered Workplaces



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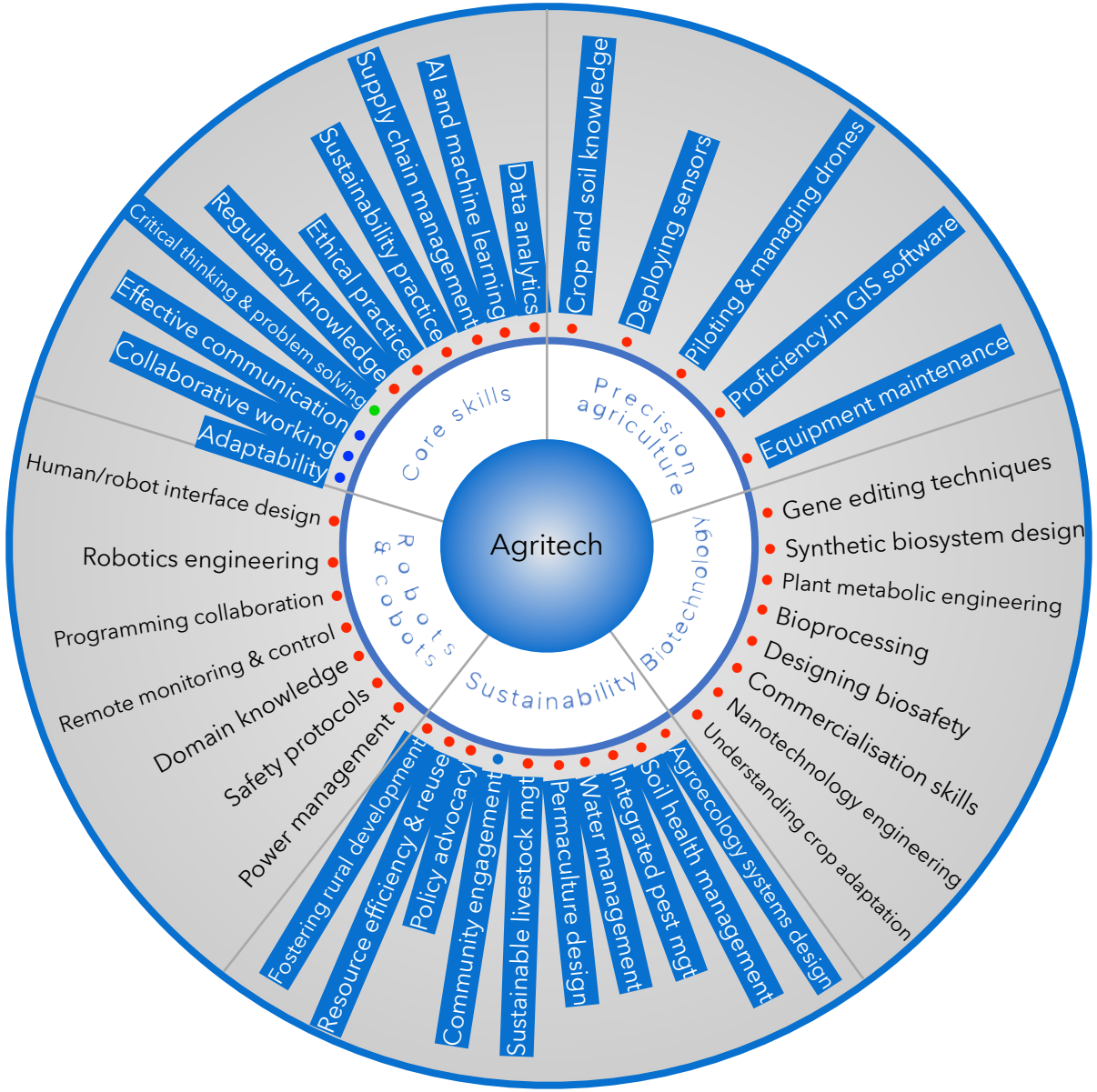
Key skills required to succeed in Shuttered Workplaces

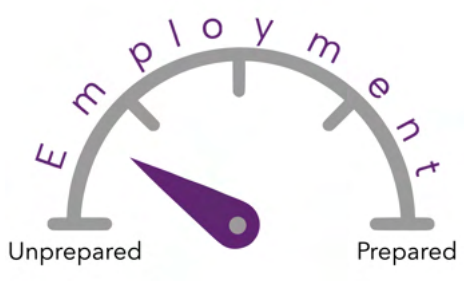


The scenarios are not predictions, projections or an assessment of current government policy

Fit of the 2023 NI skills base with the skills required to succeed in Shuttered Workplaces

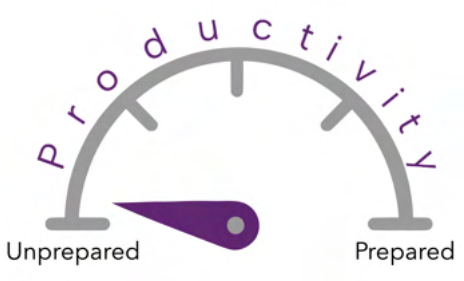
NI is perhaps better prepared for this scenario than others. NI's response to this world is narrower, but more focused. Many skills sets are in play. If NI were to focus solely on building the skill sets to thrive in Shuttered Workplaces, it would almost certainly manage to.

The danger, of course, is that NI needs to balance its choices and prepare for all scenarios as best it can; however, preparing for this scenario creates a platform that preparation for the other scenarios can build on.



This scenario presents a mix of downward pressures. Routes to employment are unlikely to be effective and government has limited policy options.

Grey economic activity is likely to be high. So is criminal activity and increased use of drugs. This is likely to create an employment deficit that NI will find hard to fix. Government policy *may* need to focus on building effective pathways to technology work that focus on younger citizens only. It will also need to explore ways to overcome cultural pressures to opt out.



This is a difficult scenario for most businesses and survival requires adaptability to changing circumstances.

Productivity is likely to rise because survival depends on it. Businesses will need to improve processes continuously; to drive costs and prices down; to develop innovative and creative routes to market; and to update skills constantly.

Technology will be one key. Lower profitability and higher costs may mean that businesses collaborate more to share resources and equipment.

Existing welfare programmes in this scenario need to be targeted towards the most vulnerable groups. Programmes may need to be stricter, with tighter criteria for qualifying for assistance and with stringent policing of claimants.

This programme will only be effective if work coaches are properly resourced. Digital wallets, digital engagement and other digital tools will not be effective - citizens' lack of trust will mean they are unwilling to carry devices that allow them to be monitored (as they see it) by the state.

Delivering success in Shuttered Workplaces

Position the high tech sector for success

1. **Protect local high tech companies and support their ability to serve local areas**

   Government should work strategically with local businesses to build their resilience to change and their ability to adapt.

   This should include programmes to develop strength in strategic foresight and change management skills for leaders.

   Government in NI is not a major procurer of technology other than in key strategic sectors in this scenario - but it can support strategic partnerships elsewhere in the UK.

   Agile, low-cost companies that can ride funding waves will find opportunities to fill gaps in areas of public provision where funding is tight but need remains high. Market legislation should facilitate this approach.

2. **Strengthen the links between high tech companies, FE/HE and the labour market**

   These linkages are key to capitalising on those areas of strength that NI has in this scenario and public policy should reinforce them. Anticipating future demand and - perhaps critically - developing a shared understanding of the dynamics of change in localising supplier networks and how they are likely to shape future competitiveness - will inform long term adaptability and labour market needs.

Delivering success in Shuttered Workplaces

Options for investing in skills systems to support tech

1. **Re-orient skills development systems around local demand**

   With less inward/outward migration, local skills gaps will become more predictable and the FE/HE sector can work closely with business and government to establish a skills ecosystem where the pipeline is managed to meet local needs.

   Government should rationalise the range of tech skills providers in NI to ensure they are part of the skills ecosystem. Managing this effectively will be critical to establishing a co-ordinated and localised community of skill providers.

2. **Support employers to strengthen their strategic foresight in tech skills**

   Support employers to take a more proactive role in skills strategy at a sectoral/regional level in general and to develop strategic foresight for their own business and sector in particular. This will not be and easy approach to promote - and will take time to develop - but will build resilience in key sectors and parts of the economy.

   Delivering this will require government to develop its own foresight and strategic support skills.

3. **Develop a strategic core skills escalator**

   Focus schools, FE and HE on developing the transferable core skills required that are key to success in this scenario. These are the core skills that cross between sectors: cybersecurity, data analytics, AI and machine learning, adaptability and collaboration.

   Developing these as core foundational skills will facilitate increased flexibility in the labour force.

4. **Adopt a more directive approach to bringing economically inactive workers back to employment**

   NI will be unable to sustain a high welfare bill in this scenario - and perhaps in others. It will also need to increase the flow of workers through the skills development pipeline. NI should explore ways to bring individuals off welfare and back into the labour market quickly and in a targeted manner. This will require a strategic approach to welfare support and investment in work coaches to drive the programme forwards.

   This will most likely need to be funded publicly.

6. Analysis and implications

Introduction

This foresight report is focussed on the future.

The first part of the report is designed to stimulate discussion on the supply side of future skills in NI. It reviews the high tech skills that NI will require in the future if it wishes to be globally competitive in the innovation intense sectors:

- Digital, ICT and Creative Industries
- Fintech
- Life and Health Sciences
- Agritech
- Advanced Manufacturing and Engineering

For each cluster, the review highlights core skills (skills required across all sectors in the cluster) and sectoral skills (skills required in one or more, but not all, sectors in the cluster).

Each skill is further categorised according to whether it is

- a foundational and higher order skill that encompasses the ability to understand complex ideas, adapt effectively to the environment, learn from experience, and reason.
- a socio-emotional skill which describes the ability to manage relationships, emotions, and attitudes. These skills include being able to navigate interpersonal and social situations effectively, as well as leadership, teamwork, self-control and determination.
- a specialised skill such as the acquired knowledge, expertise, and interactions needed to perform a specific task, including the mastery of required materials, tools or technologies.

The second part of the report is designed to stimulate discussion on the demand side of future skills in NI. It introduces four scenarios that describe alternative ways the global economy - and consequently Northern Ireland's economy - might develop over the next 15 years.The scenarios set out a range of possible outcomes, opportunities and challenges Northern Ireland might face in the future and explore how these varying conditions might impact on markets and demand for the high tech skills set out in the first part of the report. The scenarios are not predictions but models of future uncertainty.

This part of the report draws out some of the key conclusions from the analysis of future skills requirements and the scenario modelling. The first part sets out some broad conclusions. The second part highlights possible implications of the scenarios for improving our Innovation, Inclusion and Sustainability.

Broad conclusions

The report draws six broad conclusions from the analysis of future skills requirements and the scenario modelling:

- Core skills in technology sectors are changing constantly
- Socio-emotional skills are key to future strategic adaptability
- The Digital, ICT and Creative Industries cluster is in the top two most important clusters in all scenarios
- Other clusters vary in importance across different scenarios and NI therefore needs to strengthen its strategic foresight capability to anticipate change
- NI's technology focus *may* be too broad and *may* need to be narrowed
- Government and business may need to work more closely with FE and HE to shape the future technology skills pipeline

Core skills in technology sectors are changing constantly

The pace of change in technology development continues to accelerate. So does the speed of deployment of technology into existing markets and the rate at which new technologies create new markets and new opportunities.

Capitalising on new market opportunities and defending existing market share will require successful economic actors - whether individuals, businesses or governments - to anticipate and adapt to change at an increasing rate.

This will require actors to *continuously* monitor how core skills are changing - and to be willing and able to adapt quickly in line with market requirements.

Socio-emotional skills are key to future strategic adaptability

Specialised skills - the acquired knowledge, expertise, and interactions needed to perform a specific task, including the mastery of required materials, tools or technologies - remain the dominant skill type across all clusters, accounting for 7 out of 10 of the skills listed in this report.

Socio-emotional skills - managing relationships, emotions, and attitudes - account for 2 out of 10 skills required across all clusters.

The relative importance of socio-economic skills changes significantly across all core skills, however, accounting for 4 out of 10 of core skills. This reflects a growing trend highlighted in the 2023 ISE (Institute of Student Employers) Recruitment Survey that skills-base hiring - where an employer places less emphasis on academic qualification levels and more on experience, transferable skills and potential - is increasing.

The Digital, ICT and Creative Industries cluster is in the top two most important clusters in all scenarios

It is perhaps unsurprising that the Digital, ICT and Creative Industries cluster is one of the top two most important clusters in each scenario.

However, this masks an important observation that the Creative Industries are only significant to NI in one scenario. This may be an unfair interpretation of the narratives - and policy makers must decide that for themselves - but it fits the scenario logics.

This does not of course mean that Creative Industries have no value in those scenarios where they appear to be less important - but that they *might* be less in demand.

Policy makers may wish to explore the potential vulnerabilities of the sector to future change. These vulnerabilities have less to do with the state of the sector in NI – which is growing rapidly and is performing strongly at present - than it is to do with the state of the global industry and the changing global market dynamics. Tracking these dynamics to identify any future vulnerabilities *before* they emerge would ensure policies to build resilience can be introduced in advance of need.

Other clusters vary in importance across different scenarios and NI therefore needs to strengthen its strategic foresight capability to anticipate change

Other clusters vary in importance across different scenarios, which creates a policy dilemma: how can NI anticipate when to invest more in one cluster than in another? And how can it switch resources quickly and timeously as required to sustain competitiveness?

We suggest that NI establishes a horizon scanning programme that can identify the global forces pushing the world - and consequently NI - towards one or other of the scenarios. Such a programme could, for example, produce strategic insight reports that highlight deeper developments and long run trends in each sector - and identify future resourcing options.

NI's technology focus *may* be too broad and *may* need to be narrowed

A related point that flows from the scenarios is that NI may be looking at too wide a range of technologies and may need to concentrate resources in a smaller number of clusters. Doing so, we suggest, could strengthen NI's capacity to adapt quickly.

In exploring this further, we suggest that NI consider

- Its existing skills pipeline for each cluster and how quickly and easily it can build resilience across the skills base from within
- Which parts of the skills base are exposed - that is, are not resilient
- To what extent NI can acquire skills quickly - either through strategic partnerships outside NI or by bringing skills in - to plug any gaps

Matrix should use the scenarios to broker these conversations across government; and should do so quickly.

Government and business may need to work more closely with FE and HE to shape the future technology skills pipeline

One scenario in particular - *Shuttered Workplaces* - emphasises the importance of FE and HE in working closely with government and business to design a curriculum that builds the skills that NI needs.

We recommend that Matrix consider what role they could play in presenting these scenarios to FE and HE in order to promote discussion of the relationship with business and to understand their perspective on - and capability for - adapting curricula and teaching and learning practice and to accommodate the uncertainties highlighted in the scenarios and in this analysis. Some technologies and clusters are important for NI's success in all the scenarios; others are less important in some conditions.

Possible implications for improving Innovation, Inclusion and Sustainability goals

This section of the report explores how easy it is likely to be for NI to improve its innovation, inclusion and sustainability in the four scenarios.

The tables and analysis on pages 125-130 explore each of these objectives in turn and our commentary on pages 131-132 highlights the key messages for policy emerging from the analysis.

A brief reminder of the purpose and provenance of the scenarios

The purpose of the scenarios is to

- Explore alternative ways the world might develop and how technology and access to skills might shape future regional competitiveness
- Test Northern Ireland's technology and science capabilities and determine areas of excellence where it has competitive edge and resilience
- Examine the challenges and opportunities for achieving Innovation, Inclusion and Sustainability across the scenarios and highlight the implications for policy.

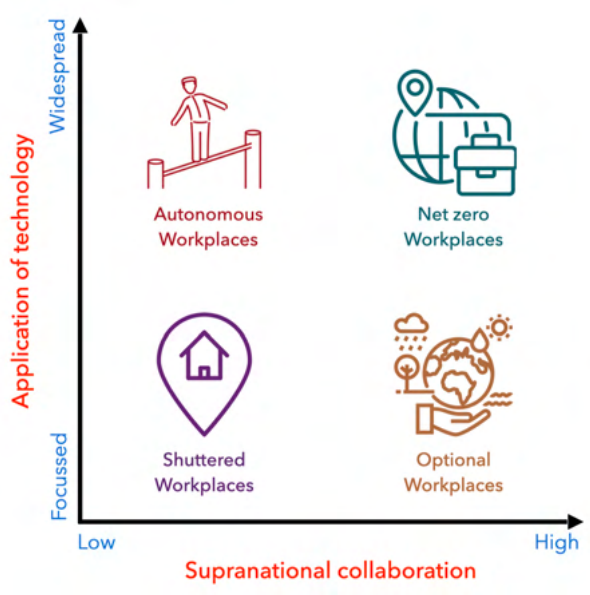
Firetail developed the scenarios to understand the structural characteristics of NI's economy and the forces shaping their development from the present day to 2035. The drivers and scenario framework were developed through a mix of interviews and workshops and Firetail wrote the detailed narratives. Waverley Consulting have updated some elements of the narratives to reflect changes in policy thinking post pandemic. These updates have not changed the fundamental logics of the scenario framework.

The scenarios are framed by two axes.

The first axis - supranational collaboration - relates to the uncertainty surrounding the global response to net zero and other emerging global challenges such as poverty, healthcare and global security.

The second axis - application of technology - relates to uncertainty surrounding the uptake and use of technology to tackle global issues and to drive economic growth.

Combining these two axes creates a scenario matrix that defines four alternative outcomes:



- Autonomous Workplaces describes a future where the application of technology is widespread and supranational collaboration is low. Technologies are used to manage workflow and cut costs.
- Net Zero Workplaces describes a future where the application of technology is widespread and supranational collaboration is high. Talent is in demand and corporates and skilled staff work flexibly and move constantly, fuelling competition.
- Optional Workplaces describes a future where the application of technology is focused and supranational collaboration is low. Economic activity and growth have slowed worldwide as governments focus resources on redesigning communities to support low carbon living and working.
- Shuttered Workplaces describes a future where the application of technology is focused and supranational collaboration is low. The world order is changing; the east is on the rise and the west moves in and out of recession. International tensions rise as the east assumes control of - and access to - global solutions.

Using the scenarios to test the opportunities for and challenges to improving Innovation, Inclusion and Sustainability in the future.

The tables on the following pages examine how favourable each scenario is for improving Innovation, Inclusion and sustainability.

The analysis on pages 131-132 draws out the key messages for policy makers.

Innovation

The headline objective for innovation is *to have a high performing economy driven by innovation underpinned by high levels of collaboration across business, academia, government and civil society.*

Contributing objectives on innovation are to increase

- the number of R&D performing businesses in NI
- innovation active firms by 2030
- innovation start ups

These objectives are set out in the table on the next page and tested against the four scenarios.

The analysis shows that

- The headline objective is fully achieved in two scenarios: *Net Zero Workplaces* and *Autonomous Workplaces*.
- Two contributing objectives are fully achieved in *Net Zero Workplaces*. Embedding innovation in the wider business base remains a challenge, although NI is doing considerably better than at present.
- Limited progress is made on the contributing objectives in *Autonomous Workplaces* due to the dominance of large corporates and lowered levels of entrepreneurialism in NI
- Progress towards achieving the objectives is limited at best and in danger of not being achieved at all in *Optional Workplaces.* This is primarily due to circumstances beyond NI's control. The labour force is active and employed but there are limited opportunities in this economy for high tech employment.
- Innovation is limited to a few tech sectors in *Shuttered Workplaces -this* is a hostile scenario to NI's objectives for innovation. The core problem is that there are insufficient opportunities for economic growth.

Innovation objectives	Autonomous Workplace	Net Zero Workplaces	Optional Workplaces	Shuttered Workplaces
Economic growth	• Slow	• Strong	• Low	• Flat
Growth in high tech jobs	• Thousands of high tech jobs generated in the last decade	• High. NI is attractive to mobile high skill tech workers	• Flat	• Limited to strategic sectors • Government trying to increase high skills development
A high performing economy driven by innovation	• Strong focus on tech as the route to economic security • Strong innovation infrastructure	• NI enjoys a high tech innovative culture • A highly mobile workforce increases the rate of adoption of new tech and new ideas	• NI has lost technology talent to other economies • Employment is high. Workers are overqualified	• Innovation is weak across all sectors
High levels of collaboration	• Government has to pick winners • Strong regional partnerships drive growth	• Strong collaboration between business, universities, government and civil society enable sustained growth	• Only exist where government leads	• Government, business and FE/HE are working together in limited areas to improve efficiency
Increase in innovation start ups and performing businesses	• Limited and focussed on strategically important sectors	• Significant • High levels of entrepreneurship	• No increase in innovation start ups	• Not achieved. There is little entrepreneurial energy
Increase in innovation across the wider business base	• Limited and focussed on strategically important sectors	• Increasing, but more to do	• Limited sector specific increase in innovation across the business base	• Not achieved. There is little culture of innovation outside the tech sector
Overall Innovation Rating				

Fully achieved in the scenario | Partially achieved in the scenario | Limited progress | At risk of not being achieved | Unachievable in the scenario

Inclusion

The headline objective for inclusion is *to create opportunities for economic growth which are distributed across society to benefit everyone*.

Contributing objectives on inclusion are to close the employment gap between

- males and females
- individuals with and without a disability
- least deprived vs most deprived

These objectives are set out in the table on page 128 and tested against the four scenarios.

The analysis shows that

- The headline objective is only fully achieved in one scenario: *Net Zero Workplaces*
- Two contributing objectives are fully achieved in *Net Zero Workplaces* but closing the employment gap between the least and most deprived members of society is only partially achievable
- The headline and contributing objectives are partially achieved in *Autonomous Workplaces* - although, once again, closing the employment gap between the least and most deprived members of society lags. In this scenario, the objective is at risk of not being achieved
- Limited progress is made towards achieving the headline objective in *Optional Workplaces* - and the contributing objectives are all at risk of not being achieved
- *Shuttered Workplaces* is a hostile scenario to NI's objectives for inclusion. The core problem is that there are insufficient opportunities for economic growth and, consequently the contributing objectives are not achieved.

Inclusion objectives	Autonomous Workplace	Net Zero Workplaces	Optional Workplaces	Shuttered Workplaces
Economic growth	• Slow	• Strong	• Low	• Flat
Growth in high tech jobs	• Thousands of high tech jobs generated in the last decade	• High. NI is attractive to mobile high skill tech workers	• Flat	• Limited to strategic sectors • Government trying to increase high skills development
Distribution of opportunities across society	• Strong focus on building progression routes • …but distribution remains a challenge	• Strong service sector creates jobs	• Uneven distribution of opportunities across the economy	• On a downward slide • Skills and qualifications are declining
Employment gap between men and women	• Fewer women in high tech roles • More even distribution of men and women in low skill jobs	• Closing in both high tech and service sectors	• Increased	• Little change • Employment is falling
Employment gap between those with and those without a disability	• Reduced, but not significantly	• Closing in both high tech and service sectors	• Still high but welfare reforms support many unable to work	• Unchanged from 2024
Employment gap between least and most deprived	• Reduced, but due to levelling down rather than levelling up	• Closing, but more to do	• Still high but welfare reforms support many unable to work	• Unchanged from 2024
Overall Inclusion Rating				

Sustainability

The headline objective for sustainability is *to double the size of NI's low carbon and renewable energy economy to more than £2bn turnover.*

We have added three additional contributing objectives to support discussion:

- achieve net zero by 2050
- increase investment in nature
- achieve a just transition for NI

These objectives are set out in the table on page 130 and tested against the four scenarios.

The analysis shows that

- The headline objective is only fully achieved in one scenario: *Net Zero Workplaces*
- Two of the contributing objectives are fully achieved in *Net Zero Workplaces* but a just transition is only partially achieved
- Sustainability suffers in both *Autonomous Workplaces* and *Shuttered Workplaces*. Some progress is made towards the headline objective but none of the others are achieved
- Sustainability does better in *Optional Workplaces;* invest in nature suffers - and progress is slow in the remaining objectives due to economic circumstances - but the overall trajectory is in the right direction

Sustainability	Autonomous Workplace	Net Zero Workplaces	Optional Workplaces	Shuttered Workplaces
Economic growth	• Slow	• Strong	• Low	• Flat
Growth in high tech jobs	• Thousands of high tech jobs generated in the last decade	• High. NI is attractive to mobile high skill tech workers	• Flat	• Limited to strategic sectors • Government trying to increase high skills development
Achieving 80% electricity consumption from renewable resources	• Offshore energy production is limited and shared across the UK • Land based renewable production is underinvested	• Driven largely by land based energy production and willing changes in consumer behaviour	• Some inroads due to reftrofitting of housing stock and energy efficiency savings	• Offshore energy production is limited and shared across the UK • Land based renewable production is underinvested
Progress towards net zero	• Behind schedule • Companies pursue economic growth at all costs • Society is not engaged	• Early focus on net zero drives innovation and change	• Building, but slowly. Driven by a focus on 20 minute neighbourhoods	• Insufficient funds and consumer resistance to high prices have resulted in limited progress
Invest in nature	• Economic benefits outweighs environmental cost	• Transition to nature positive agriculture • Focus on land and sea based diversity	• Not achieved. Government is considering rearguard action	• Government cannot afford (economically or politically) to invest
Achieve a just transition	• Not achieved	• Just transition is not fully achieved but progress is significant and continuing	• More progress in urban centres but rural areas are not delivering	• Not achieved
Overall Sustainability Rating				

Fully achieved in the scenario | Partially achieved in the scenario | Limited progress | At risk of not being achieved | Unachievable in the scenario

Analysis

These scenarios are not predictions. Some parts of the narrative may happen in the future and some may not; some actors may choose to behave in ways the scenarios depict, others may not. The only aspect of the scenarios that is certain is that the future will not look like any one of them – it will be a combination of some of the elements they describe and other elements that have not yet been thought about.

The scenarios are not meant to be 'right', but to offer interesting (and in some cases challenging, stretching or controversial) pictures of the future. They are a thought experiment that policy makers can use to explore the dynamics of change and to rehearse the policy choices and decisions they are likely to face on the path to success.

Analysis of the tables in this section shows how easy - or challenging - it will be to achieve Innovation, Inclusion and Sustainability across the scenarios. The analysis highlights that

- The conditions for achieving all three - Innovation, Inclusion and Sustainability - are ***only favourable*** for NI in one scenario: *Net Zero Workplaces*.

  This does not mean that Innovation, Inclusion and Sustainability ***will*** be achieved in *Net Zero Workplaces* - government and its partners will still need to implement policies for delivering them - but that the task will be easier.

- The conditions for achieving Innovation and Inclusion are ***relatively favourable*** in *Autonomous Workplaces* - but the scenario suggests that, to be effective, policy interventions will need to be different to those in *Net Zero Workplaces*. In particular, policy makers may need to develop more focussed interventions to boost innovation startups and to strengthen innovation in the existing business base.

  They may also need to focus considerable effort on closing the gap between the richest and poorest in society; although this will be challenging in this scenario where average income will be lower than in *Net Zero Workplaces*.

- Sustainability ***will not*** be achieved in *Autonomous Workplaces* without significant changes to government policy that prioritise the pursuit of net zero over economic growth. This will be challenging due to the potential consequences for society and, if the policy environment that is in place in the UK in 2023 remains, the lower priority placed on net zero by the UK government.

- *Shuttered Workplaces* is a deeply challenging scenario for NI. Innovation, Inclusion and Sustainability are ***all unachievable*** under these scenario conditions. Failure is, perhaps, a cultural issue as much as an economic one.
- *Optional Workplaces* is a fairly challenging scenario for NI. Some progress is made towards delivering Sustainability but Innovation and Inclusion are at risk, primarily because of limited technology opportunities. Despite these outcomes, *Optional Workplaces* is a fairly positive scenario from a societal perspective.

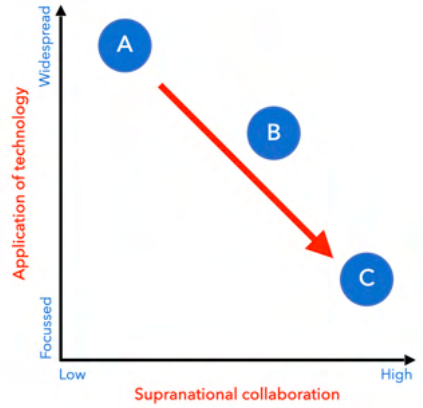
Implications for delivering economic policy

The scenarios highlight key strategic risks to delivering Innovation, Inclusion and Sustainability over the next decade. Policy makers can use the scenarios to explore these risks further and, by doing so, can identify where they might need to adapt policy.

To do so, policy makers should first **determine the baseline** by agreeing where the global and NI economies currently sit in the scenario space that frames the four scenarios (point A in the schematic on this page.)

Policy makers should then **identify the direction of travel** by using horizon scanning and trends analysis to determine what forces are acting on the global and NI economies and to agree which direction these forces are pushing the economy in (vector B).

Policy makers can then a**gree what the final destination is likely to be** (point C) and use the scenarios to explore what it might mean for the economy and for high technology skills in NI.



Finally, policy makers can use this analysis to determine

- Whether the current direction of travel is favourable for NI and, in particular, for delivering Innovation, Inclusion and Sustainability
- What future vulnerabilities and risks the NI economy might face in the policy areas
- What NI can do *now* to ameliorate future challenges and to capture future opportunities
- What global trends NI needs to track to determine the future conditions for delivering economic policy objectives
- What future developments will trigger further policy interventions to optimise the chances of success

7. Recommendations

We have identified a number of recommendations emerging from the study. They are

1. Matrix should share this report widely across DfE and beyond. It should proactively offer to present the scenarios and discuss the findings and the options for positioning the high tech sector for success and for investing in the skills systems to support technology development.

2. Perhaps as part of this conversation - or perhaps separately - DfE should broker a further series of conversations across government about whether its current technology focus is too broad - or whether it should be more narrow.

3. DfE should work closely with other parts of government and with relevant external bodies to continuously monitor how core technology skills are changing and to explore what they might mean for NI in the near, mid and long term future.

4. These conversations should be underpinned by trends analysis and should utilise the scenarios in this report - and wider future thinking tools as appropriate - to explore shifting market dynamics and support anticipatory policy making.

5. To support this, DfE and its partners should establish a skills foresight and horizon scanning programme to map future trends and developments in the global economy and to establish an early warning system that can identify future vulnerabilities in key technologies and clusters.

6. The knowledge and strategic insights that flow from such a skills foresight and horizon scanning programme should be shared widely across government on a regular basis and used to support development of policies to build resilience.

7. DfE and its partners should explore whether current policy needs to be adjusted to ensure that NI's future workforce will have the socio-emotional skills and foundational and higher order skills that will be required for success in the future.

8. DfE and its partners should also explore whether future skills training and development infrastructure will need strengthened to meet NI's future requirement for specialised skills across all technology sectors.

9. The scenarios highlight key strategic risks to delivering Innovation, Inclusion and Sustainability over the next decade. We recommend that DfE and its partners use the scenarios to explore these risks further and to identify how to adapt policy to achieve its economic ambitions.

10. The scenarios should also be used to support longer term policy thinking to underpin longer term objectives.

11. Further study of the impact of AI and generative AI on future skills needs in Northern Ireland's economy should be supported. By understanding how automation and AI will reshape the workforce, policymakers will be able to create effective education and training programs. This will help ensure the workforce remains competitive and adaptable while developing good jobs and place-based growth.

12. Industry leaders should be tasked with leading the development of education adaption programmes for AI and associated technologies, including outlining curriculum focus and programme content. These programmes should encourage social inclusion and broadest positive impact for all young people.

8. References

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