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Talent for Ireland's Green Economy
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Examining Skill Needs to **Support Enterprise Innovation and Ireland's Transition to a Low-Carbon Economy**

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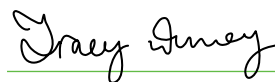
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Foreword

At a domestic level, the need to accelerate the transition to a Net Zero Carbon Economy is reflected in Government's 2030 and 2050 targets set out in the Climate Action and Low-Carbon Development (Amendment) Bill 2020, with binding targets for emission reduction over the next decade, and ultimately, carbon neutrality by the year 2050.

The shift to a net zero carbon economy over the next thirty years will lead to widespread changes in sectors and occupations, the phasing out of some jobs but also demands for new talent, skills and capabilities, bringing with it new employment opportunities and sustainable economic growth. This report sets out to define both the current and emerging talent needs within Ireland's private enterprise sector that are required to enable the transition to a net zero economy. The report considers for example how leadership is essential in providing strategic direction for the enterprise and in encouraging employees to engage with climate action and sustainability issues, enabling green innovation and the formation of sustainable behaviours.

Practically, this report identifies the specific skills and capacities that a low carbon economy demands. The report also recommends an increased focus on building capability in areas such as corporate sustainability strategy, energy-efficiency design and having the right tech skills to harness the digital technologies that will enhance the firms' capacity to achieve long term sustainable performance.

Skillnet Ireland is engaging widely with industry to develop the skills framework that will boost Ireland's capacity to accelerate the green transformation, build sustainable businesses and fuel sustainable innovation through our Skillnet Business Networks and our Climate Ready initiative.

On behalf of Skillnet Ireland I would like to thank all of the contributors who have generously given their time and expertise to this report. I would also like to express my thanks to the members of the project Steering Group for their insights and support. Finally, I wish to acknowledge the support of our research partner for this report the ESRI, together with Professor Iulia Siedschlag and her team, for their excellent work in bringing the report to a successful conclusion.

Executive Director
Skillnet Ireland

Executive **Summary**

It is widely acknowledged that the transition to a low-carbon economy requires structural change across sectors and occupations and intensified innovation efforts. In this context, skills gaps are increasingly recognised as a major obstacle in sectors closely linked to the 'green economy'.

At the same time, the transition to a low-carbon economy generates skill needs across other sectors, as businesses, workers and entrepreneurs have to rapidly adapt to changes as a consequence of environmental policies.

Against this background, this research study examines current and emerging skill needs within Ireland's private enterprise sector to enable innovation and support the transition to a low-carbon economy. More specifically, this research provides novel evidence on:

Business awareness of and exposure to climate change challenges

Skill needs in the medium term to support enterprise innovation activities and the transition to a low-carbon economy

Existing upskilling programmes and future training needs to develop the necessary skill sets

Key Research **Findings**

1 Awareness of and Exposure to Climate Change Challenges

A large proportion of enterprises (80%) are aware of the European Green Deal, the EU plan to achieve climate neutrality by 2050. Almost 60% of enterprises which are aware of the European Green Deal, associate achieving carbon neutrality by 2050 with a positive impact in the medium term on enterprise performance while 31% of enterprises think the impact will be neutral. Only 10% of enterprises perceive achieving this goal as having a negative impact on their enterprises. Almost one third of respondents in the construction sector who are, aware of the European Green Deal think it will impact negatively on their enterprises.

Awareness of Ireland's Climate Action Plan is very high (91% of enterprises). Developing new skills within the enterprise workforce appears to be the top challenge from the implementation of Ireland's Climate Action Plan enterprises face in the medium term. The next two most important challenges are improving the way in which resources are used in their supply chain to reduce emissions; and improving energy efficiency of processes, buildings and transport.

A large proportion of enterprises anticipate that measures for the adjustment of production patterns required to address climate change will affect them in the medium term (63% of all enterprises). Other measures expected to impact a large proportion of enterprises include compliance with regulations; implementation of new technologies, reducing carbon emissions, and adjustment of consumption patterns. Looking at responses by enterprise groups, SMEs appear to be most exposed to measures relating to adjustment of production patterns (73% of respondents) while large enterprises identify implementation of new technologies as the

main set of measures to address climate change that will affect their activity in the medium term (75% of respondents). For Irish-owned enterprises, the measures that will affect their activity most appear to be expanding recycling efforts (72% of respondents). Adjustment of production patterns is perceived as the top exposure for foreign-owned enterprises (85% of respondents). Enterprises in industry are most exposed to expanding recycling efforts (80% of respondents) while enterprises in the services sector are most exposed to implementation of new technologies (67% of respondents). Measures for the adjustment of production patterns appear to affect most of enterprises in the construction sector (88% of respondents).

2 The Impact of the Transition to a Low-Carbon Economy on Skill Needs

Three quarters of enterprises anticipate that the impact of the transition to a low-carbon economy will come through a shift of activities from less to more energy efficient and less polluting activities. For both SMEs and large enterprises the impact of the transition to a low-carbon economy on skills needs is expected to come mainly through a shift of activities from less to more energy efficient and less polluting activities. Emerging new occupations following on from new regulations and the development of new technologies has been identified by large enterprises as an equally important channel for the impact of the transition to a low-carbon economy on skill needs.

3

Skill Needs in the Medium Term to Support Enterprise Innovation Activities and the Transition to a Low-Carbon Economy

The top skill sets needed in the medium term to support enterprise innovations with environmental benefits include climate change and sustainability strategy skills; marketing skills; and financial skills relating to investment and access to finance. Looking across enterprise groups, climate change and sustainability strategy skills to support green innovation were identified as needed in the medium term by over three quarters of respondents in all groups with the exception of large enterprises. Three quarters of respondents in large enterprises identified a broader range of skills to support green innovation which are needed in the medium term: sector-specific technical skills; web design; mathematics, statistics and data management; organisational and leadership skills. Financial skills relating to investment and access to finance together with climate change and sustainability strategy skills are the most needed green innovation skills for foreign-owned respondents. Financial skills relating to investment and access to finance were identified as the most needed green innovation skills for respondents in the construction sector.

The following patterns emerge for innovation skills that support green innovations:

- **Skills with high-demand and low supply/high recruitment difficulty:** Climate change and sustainability strategy skills.
- **Skills with high-demand and high supply/low recruitment difficulty:** Sector-specific technical skills; Software development; Web design; Marketing skills.
- **Skills with low demand and high-supply/low recruitment difficulty:** Engineering and applied science skills; Mathematics, statistics and data management skills; Organisational and leadership skills; Multimedia skills; Financial skills relating to investment and access to finance.
- **Skills with low-demand and low-supply/ high recruitment difficulty:** C: Design skills.

The top skill sets needed in the medium term to support the transition to a low-carbon economy identified by enterprises include: waste management skills; corporate sustainability strategy skills; carbon management skills; and sustainable finance skills. The full range of green skills analysed were identified as needed in the medium term by over half of respondents across all enterprise groups. Corporate sustainability strategy skills tops the range of green skills needed for all enterprise groups with the exception of large enterprises and the industry and services sectors. Carbon management skills are the most needed green skills for large enterprises and Irish-owned enterprises, while waste management skills tops the green skill needed for enterprises in the services sector.

The following patterns emerge for green skills that support the transition to a low-carbon economy:

- **Skills with high demand and low supply/ high recruitment difficulty:** Corporate sustainability strategy skills; Energy-efficiency design skills; Green procurement skills.
- **Skills with high demand and high supply/ low recruitment difficulty:** Carbon management skills; Water management skills.
- **Skills with low demand and high-supply/ low recruitment difficulty:** Waste management skills; Building and retrofits skills; Sustainable transport and logistics skills; Sustainable finance skills.

4

Training Needs in the Medium Term to Support Green Innovations and the Transition to a Low-Carbon Economy

Examining training needs for green innovation skills in the medium term, multimedia skills has been identified as the most demanded. The next most demanded training programmes are on organisational and leadership skills, and marketing skills. Across all enterprises groups, those identified by at least 50% of respondents include training on software development; organisational and leadership skills; multimedia skills; web design (all groups with the exception enterprises in the services sector); engineering and applied sciences skills (all groups with the exception of enterprises in the services sector); mathematics, statistics, and data management skills (all groups with the exception of enterprises in the construction sector); marketing skills (all with the exception of enterprises in the construction sector).

Among the analysed green skills to support Ireland's transition to a low economy, training in corporate sustainability strategy skills is the most needed in the medium term. The next most needed training programmes are for sustainable finance skills and energy-efficiency design skills. The need for training in corporate sustainability strategy skills has been identified by over 50% of respondents from all enterprise groups (78% of respondents from the industry sector; 75% of respondents from the construction sector; 69% of respondents from SMEs and Irish-owned enterprises).

The above key findings were validated to a large extent by the views of stakeholders collected during two workshops organised as part of this research. The discussions also highlighted a range of issues related to skill sets and training programmes needed to support enterprises to adapt to and mitigate challenges from climate changes in the medium term.

Key Recommendations

Taken together, the results of this research suggest a number of key takeaways for designing training programmes to support enterprise innovation and the transition to a low-carbon economy:

• **Training programmes are needed to guide enterprises through the complexity of the various pieces of legislation and policy objectives and targets.** In particular, there is a need for more clarity and a "Road Map" to achieving a low-carbon economy. Concepts such as the "circular economy" need to be contextualised to each business given the variety of business activities.

• **Developing and providing training programmes to businesses on a continuous basis** is needed given the uncertainty and dynamics of climate change challenges and related policy and legislation. Training programmes should aim at enabling and fostering a culture of circularity/ green economy.

• **Training programmes focused on developing skills and talent to support innovation and the transition to a low-carbon economy should prioritise developing skill sets which are in high demand and low supply** including: climate change and corporate sustainability strategy skills; energy-efficiency design skills; green procurement skills.

• **Tailored training programmes to each sector/enterprise group and at different stages in the transition to a low-carbon economy** would help businesses to better act and manage the transition to a low-carbon economy. Programmes to train in-house leaders/experts to lead companies' transition would provide external and tailored support/roadmap for each business.

• **Enhancing collaboration and co-ordination of different initiatives is important.** A range of government departments and agencies provide various training programmes for businesses. It would be useful to integrate these programmes together to ease accessibility and to reduce duplications.

1. Introduction

1.1 Research and policy context

The challenge of climate change and its consequences on the environment, society and the economy has led to a wealth of research-based evidence and on this basis a range of new policy frameworks and programmes have been put in place to enable and accelerate the transition to a low-carbon economy and a more sustainable long-term development. The European Commission has set up the goal for the European Union economies to become carbon-neutral in 2050. This ambitious goal and an intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030 compared to 1990 have been included in the European Climate Law, a binding legislation. In line with these commitments, Ireland's Climate Action Plan sets out the path to achieving ambitious national targets for 2030 and 2050. Developing the new skills and technologies required is part of the agenda put forward to ensure that enterprises and sectors remain resilient and competitive in a low-carbon economy.

It is widely acknowledged that the transition to a low-carbon economy requires structural change across sectors and occupations and intensified innovation efforts (Ayres and van den Bergh 2005; OECD 2017). In the case of Ireland, De Bruin et al. (2019) find that the transition to a low-carbon economy will result in labour demand changes across sectors. The largest negative effects on labour demand will be in mining (a reduction of 6%) and transportation (a reduction of 5%) while a number of sectors will experience positive effects.

Skills gaps are increasingly recognised as a major obstacle in emerging sectors closely linked to the 'green economy', such as renewable energy, energy and resource efficiency, renovation of buildings, construction, environmental services, and manufacturing (CEDEFOP 2018). At the same time, the transition to a low-carbon economy generates skill

DIGITAL TECHNOLOGIES

foster the transition to a low-carbon economy

ENERGY SECTOR

· ·

has highest proportion of investment in equipment linked to cleaner technologies

GREEN INNOVATION

is a key driver of sustainable long-term economic growth

needs across other sectors, as businesses, workers and entrepreneurs have to rapidly adapt to changes as a consequence of environmental policies. To ensure a smooth transition of workers across sectors and the transferability of skills from declining to emerging sectors, well-designed targeted training programmes are crucially important (OECD 2018).

Recent international evidence indicates that accelerating the development of new low-carbon technologies and promoting their global application are crucially important steps towards enhancing environmental quality and efficiency (Carrión-Flores and Innes 2010; Costantini et al. 2013; Voigt et al. 2014; Ghisetti and Quatraro 2017). The transition to a climate-neutral economy and a more sustainable long-term economic growth require enterprises to invest more intensively in green technologies. Siedschlag and Yan (2021) find that in Ireland the proportion of firms with green investments is low. Over the period 2008-2016, on average, less than 5% of enterprises with 20 or more employees invested in equipment linked to environmental protection in a given year. The energy sector had the highest proportion of enterprises with investment in equipment linked to cleaner technologies, around 20% over the same period. This research also found that larger enterprises, importers, and enterprises which were part of an enterprise group were more likely

to invest in equipment for pollution control and in equipment linked to cleaner technologies.

Economic theory and recent international evidence have established that green innovation is a key driver of sustainable long-term economic growth.[1] Understanding what drives the propensity of firms to introduce innovations with environmental benefits could improve the knowledge-base of policies aiming to incentivise firms to invest in green innovations. Siedschlag, et al. (2019) examined the propensity of enterprises in Ireland to introduce innovations with environmental benefits (green innovations). The results of this research indicated that environmental regulations, in-house research and development (R&D) activity and acquisition of capital assets are major drivers of green innovations. Larger enterprises were more likely to introduce green innovations. This result holds across all enterprises as well as for enterprises in the manufacturing sector, Irish-owned and foreign-owned enterprises. The propensity of services firms to introduce green innovations was found to be higher for enterprises in the same industry with other green innovators.

There is growing evidence indicating that digital technologies foster the transition to a low-carbon economy and that access to digital skills is a key factor to enable and maximise enterprises' capacity

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[1] Smulders, Toma and Withagen (2014) provide a review of this literature.

to innovate and to support their transition to a low/zero carbon economy in all sectors (EIB 2021). Recent evidence from Ireland and other European countries shows that the demand for digital skills in the enterprise sector is not sufficiently met. Available data for 2019 from the Community Survey on ICT usage and e-Commerce[2] show that a large proportion of enterprises which have tried to recruit for jobs requiring ICT specialist skills had difficulties to fill such vacancies. In the case of Ireland, 54% of enterprises with 10 and more employees which recruited or tried to recruit for jobs requiring ICT specialist skills had difficulties to fill such vacancies. Such difficulties have affected 65% of large enterprises and 53% of small and medium-sized enterprises (SMEs). Across sectors, the most affected were enterprises in Transportation and storage, (78% of recruiting enterprises), Electricity, gas, steam air conditioning and water supply (71% of recruiting enterprises), and the ICT sector (67% of recruiting enterprises).

Executives' awareness of issues related to environmental quality and their leadership skills to enable green transformations have been identified as being among the most important skills to facilitate an enterprise transition to a low-carbon economy (Singh et al. 2020). Leadership skills are essential to provide a vision and strategy for the enterprise and to motivate employees to engage with green issues and green innovation (Jia et al. 2018; Chen and Chang 2013; Chen et al. 2006; Zhou et al. 2018). Leadership skills are also important to support employees to acquire new knowledge and encourage their engagement in green innovation and green processes (Andriopoulos and Lewis 2010) and to improve their green performance (Dranev et al. 2020; Martinez-Conesa et al., 2017), which in return helps the organisation to achieve its growth and environmental goals.

Led by the green transformation leadership, workers within the enterprise at different levels are inspired and facilitated to form green behaviours. Furthermore, practicing green human resources management (GHRM) plays a key role in linking green leadership to each worker. GHRM is considered as the green side of general human resources management (HRM), which helps the enterprise to recruit, train, develop, and reward workers engaged in green activities (Jackson et al. 2011; Renwick et al. 2013; Pham et al. 2019).

When considering the collaboration between enterprises, skills related to green supply chain management (GSCM) are also crucial for fulfilling the green goals of an enterprise (Dubey et al. 2015). A well-designed green supply chain collaboration would allow enterprises to share the effort to achieve common environmental goals such as reducing carbon emissions along the supply chain (Zsidisin and Siferd 2001; Carter and Jennings 2004; Govindan and Cheng 2011). Seuring and Müller (2008) provide a comprehensive review of the literature on green supply chain management.

In addition, green management skills at different hierarchy levels in an enterprise may have complementary effects in facilitating the transition to a more sustainable green growth. Several studies emphasize the joint effects of different green skills in helping enterprises to achieve organisational sustainability and sustainable supply chains. For example, such complementarities could be generated by associating green leadership skills to green human resources management, and green supply chain management (Singh et al. 2020; Dubey et al. 2015; Jabbour and Sousa Jabbour 2016).

Given that the transition to a low-carbon economy often involves the design of new products, product life-cycle management skills are also important for integrating sustainability into new product design (Gmelin and Seuring 2014). The evidence also suggests that cross-functional work, market planning and formalising/standardising processes would be the success factors in the development of new products related to the transition to a low-carbon economy.

Skills and talent related to analysing big data will also affect enterprises' sustainable performance, as big data techniques provide business opportunities and challenges for enterprises along the transition to a sustainable economy, where the traditional means of acquiring and analysing data are no longer applicable (Singh and El-Kassar 2019). Several existing studies

[2] Available from the Eurostat.

Leadership Skills are essentials to...

...provide a vision and strategy

...support employees to acquire knowledge

...encourage engagement & green innovation

suggest that decision makers will need to integrate big data techniques and skills into all forms of business strategies to enhance firms' sustainable capabilities and to achieve better sustainable performance.

In response to the acknowledged need to identify and anticipate the demand for skills related to the transition to a low-carbon economy, a number of reports coordinated by international organisations and agencies have put forward taxonomies of core skill sets (ILO 2011, 2019; CEDEFOP 2015; 2018). The International Labour Organization (ILO) has played a leading role in this respect. Its report on skills for green jobs (ILO 2011) suggests a broad range of skills that are needed to support green innovation and the transition to a low-carbon economy. These include: (i) broad skills related to managing the challenges posed by the transition to a more sustainable low-carbon economy: strategy and leadership skills, adaptability and transferability skills, innovation skills, environmental awareness, coordination and management, communication and negotiation skills, system and risk analysis skills, marketing skills, entrepreneurial skills; and (ii) more specific skills related to the green economy: corporate sustainability and strategy, carbon management, waste management, energy- efficiency design, water management, building and retrofits, sustainable transport and logistics, green procurement, and sustainable finance.

In terms of policy, the importance of horizontal coordination across policy areas and vertical alignment across policy levels (supranational, national, regional and local) has been highlighted in several reports (ILO 2011; UNEP 2011; CEDEFOP and OECD 2015).

1.2 Research objectives

Against this background, the overall objective of this study is to analyse current and emerging skill needs within Ireland's private enterprise sector to enable innovation and support the transition to a low-carbon economy. More specifically this research provides novel evidence on:

- **Business awareness of and exposure to climate change challenges**

- **Skill needs in the medium term to support enterprise innovation activities and the transition to a low-carbon economy**

- **Existing training programmes and future training needs to develop the necessary skill sets**

The remainder of this report is organised as follows. Chapter 2 reviews international best practice in advanced economies of institutional arrangements for identifying and anticipating the demand for and supply of skills arising from the transition to a low-carbon economy. Chapter 3 examines skill needs to support Ireland's enterprise innovation and the transition to a low-carbon economy. The analysis is based on data collected with an online survey and consultation with stakeholders. Chapter 4 summarises the key findings and on this basis, puts forward recommendations for the development of training programmes to support innovation and Ireland's transition to a low-carbon economy. Potential areas for further research are also suggested.

2.

Institutional Arrangements for the Identification of the Demand and Supply of Green Skills: International Best Practice

In this chapter we present an overview of institutional set-ups, approaches and initiatives in advanced economies with respect to the development of green skills to enable innovation and the transition to a low-carbon economy. We first discuss institutional arrangements for the identification and anticipation of skills needed for innovation and sustainable development. We then discuss institutional arrangements for the supply of green skills. Finally, we bring together these best practice models encompassing both the demand and supply of green skills to enable innovation and the transition to a low-carbon economy.

This evidence provides useful insights for further analysis of skill needs to support innovation and the transition to a low-carbon economy in Ireland based on primary data collected with an online survey.

2.1 Institutional arrangements for the identification of the demand for green skills

Successful institutional approaches for the identification and anticipation of skills generally bring together representatives of the main stakeholders with interests in skills, including employers, workers' representatives, government ministries and agencies and providers of education and training. Although approaches and institutional arrangements vary across countries, international best practices include the features discussed below (CEDEFOP 2015; 2018).

Established institutional arrangements for the identification and anticipation of green skills are largely based on social dialogue. Institutional arrangements for the anticipation of green skills involve stakeholders at all levels, as they all have useful knowledge and capacities. Bringing together representatives of main stakeholders facilitates the identification and anticipation of green skills, and the efficiency of the implementation of policies focused on the development of skills and talent.

Most country-level key policies on green skill identification and anticipation are carried out under current institutional arrangements or arrangements that already exist. For example, countries with systems of sector skills councils would incorporate green skill anticipation into current systems. Countries with decentralized systems where skill anticipation is commissioned by ministries also use similar arrangements.

Systems of sector skills councils are more common in large countries. Sector skills councils include representatives of the main stakeholders with interests in sector-specific skills. The functions of such sector skill councils include skill anticipation, courses and training designing, and fostering innovation. Sometimes they also provide funding for training programmes and assure qualifications. Institutional arrangements for the anticipation of green skills can take various formats. Often, countries having a system of sector skills councils have also national- level councils to integrate different sector-level councils, which are responsible for cross-sector initiatives.

Box 2.1 presents a number of institutional arrangements for the identification of green skills needed in Ireland and other advanced economies.

Box 2.1	Institutional arrangements for the identification of green skills needs: INTERNATIONAL BEST PRACTICE

National Level Institutions

• In Ireland, an Expert Group on Future Skills Needs has been set up. It carries out research on green skills needed across several sectors. www.skillsireland.ie

Sector Skills Councils

• In Australia, skills for green jobs are identified and anticipated through several sector skills councils. They act in collaboration with other stakeholders through the Green Skills Agreement.

• In France, sectoral committees ("comités de filières") have been established representing the sectors that are considered most promising in creating jobs during the transition to a green economy.

• In the UK, skills anticipation are often carried out by the sector skills councils. A number of sector skills assessments were undertaken which were widely shared by the UK Commission for Employment and Skills. The skills assessments of 'emerging sectors' largely contributed to the understanding of the green economy and green skills.

• In the Republic of Korea, a Green Growth Committee (GGC) has been established to support the policy on green growth. It promotes the development of skills and human resources in renewable energy and green finance.

Sources: CEDEFOP (2015); CEDEFOP (2018).

2.2 Institutional set-up for the supply of green skills

On the supply side, the institutional set-up includes bodies involved in different stages of developing green skills including the design of programmes and qualifications as well as the provision of education and training. The involvement of stakeholders into the institutional arrangements has a key contribution to the development of green skills. Stakeholders at different levels are involved in the consultative frameworks, including government agencies, training institutions, certification bodies, companies in the private-sector, international institutions, business industry and professional associations, and trade unions.

Table 2.2 summarizes the activities related to developing green skills and the groups of stakeholders that are potentially involved.

Table 2.2 Stakeholder involvement in developing skills for green jobs: Activities and groups potentially involved	
Activities	**Stakeholders potentially involved**
Policy development, coordination, and monitoring	Government agencies, international institutions, business, industry and professional associations, trade unions
Developing or updating qualification standards, training regulations and/or qualification frameworks	Government agencies, training institutions, certification bodies, business, industry and professional associations, trade unions
Developing training and retraining programmes, curriculum design	Government agencies, training institutions, private sector companies, trade unions, international institutions
Participating in focus groups, advisory boards, working groups, tripartite committees	Government agencies, training institutions, private-sector companies, international institutions, business, industry and professional associations, trade unions
Performing training assessments and awarding qualifications	Government agencies, training institutions, certification bodies, private sector companies
Quality assurance (of education programmes and qualifications)	Government agencies, training institutions, certification bodies, trade unions
Performing or collaborating in studies (on skills needs and supply, labour market composition, sectoral developments etc.)	Government agencies, training institutions, private sector companies, international institutions, trade unions

Source: ILO (2019), p. 180.

International practice

Box 2.2 describes selected international best practices for the supply of green skills that have been documented in recent reports (ILO 2019; CEDEFOP 2015; 2018).

Box 2.2	The involvement of social partners in vocational education and training (VET) for the supply of green skills.

- In Germany, developing training programmes for the supply of green skills is based on social dialogue and consensus. Industry associations and trade unions are involved frequently in the Advisory Boards that supervise the design of training programmes.

- Denmark has 50 Trade Committees including representatives of employers and trade unions. They determine the outcomes, assessment methods, durations and standards for each vocational education and training programme.

- In France, there are 14 professional Advisory Committees, managed by the Ministry of Education. They are responsible to design new programmes, adapt existing courses to fulfil labour market needs, review current programmes, and propose new programmes roughly every five years. Social partners are included in each of the committees.

- In the UK, businesses and trade unions are given key roles in skills policy. The Unionlearn (run by the Trades Union Congress) has developed a range of activities on facilitating the transformation to the green economy, such as supporting the development of trade union policies, and creating green skills partnerships.

Sources: CEDEFOP (2018); ILO (2019).

Sectoral bodies and stakeholders at local and regional levels are also important components of the institutional set-ups in advanced economies, although the frameworks related to **the green economy are commonly provided by national authorities. Box 2.3 summarises some international best practices that have been documented in recent reports (CEDEFOP 2018).**

Box 2.3	Sectoral bodies, local and regional authorities provide trainings for green skills

- In France, 11 sectoral committees were launched in the economic sectors with the purpose to identify and create green occupations and green skills, following the Plan for Green Jobs launched in 2010 (Plan national de mobilisation pour les métiers de la croissance verte).

- In Denmark, a small island of Samsø became Denmark's renewable energy island, as it is self-sufficient for its energy needs from sustainable energies. It has an Energy Academy that provides green skills training and attracts thousands of visitors from around the world. Moreover, the local Vocational Education Centre South (EUC Syd) in Denmark also provides training programmes for green skills that focuses on new techniques relating to energy saving.

- In the UK, Liverpool City Region Local Enterprise Partnership developed strategies on green skills for the low-carbon economy. This Partnership coordinated training programmes with higher education colleges to fill the skill gaps of the local manufacturing companies producing products for offshore wind fields. It also designed programmes to upskill existing workforce and train new engineers for energy companies (e.g., Scottish Power).

Source: CEDEFOP (2018); ILO (2019).

In addition, the private sector is involved in designing and providing skills training for the green economy. Countries have used various structures and processesto ensure the systematic involvement of the private sector in delivering green skills, although the involvement may take different forms in different countries. Apart from been involved in the main institutional arrangement, the private sector can be involved in other forms outside it. Additionally, the collaboration between companies can also facilitate training programmes which are especially helpful for SMEs, as they may lack resources and capacity to provide skills training on their own. Universities are another prominent component of the institutional arrangements, which can take advantage of their autonomy to assess the demand of training programmes and provide related courses. They also engage with individual entrepreneurs to set-up targeted training programmes.

Targeted subsidies and incentives to the private sector to promote green skills are also used in some countries, however, they are not as effective so far. One example is the UK. Under the UK's Green Deal, households were able to take loans to retrofit green technologies to improve energy efficiency of their houses. Public bodies in the construction industry also developed related training courses to facilitate the reconstruction. However, the take-up of the loans was much lower than expected so as the demand for trained workers, which led to the termination of the programme in 2015.

Box 2.4 presents some selected international best practices of the involvement of the private sector and universities in the institutional arrangement set-up for the provision of green skills.

Box 2.4	The involvement of the private sector in the institutional arrangements for the supply of green skills

- In Germany, because of the VET dual system, the private sector is largely involved in skills training. The dual system coordinates both public funded vocational schools and SMEs so that programme participants spend half of time at the vocational school and the other half at companies.

- The UK has been emphasizing the role of private sector to take a lead in providing skills training since 2010.

- In Spain, the Observatory of Professions of the National Qualifications Institute (INCUAL), which identifies the changes of occupations and the skill needs, includes companies and social partner representatives as important components. Private companies are part of the General Council of Vocational Training, the main advisory body for the government's VET related decisions. In addition, private companies and other stakeholders can also suggest new VET programmes through communication with the Ministry of Education.

- In France, there are several channels though which the private sector is involved in the provision of training programmes. Companies can pay a training contribution as a proportion of the payroll to workers, which is managed by State approved organisations (OPCAs). They can also anticipate and identify internal jobs and skills and directly finance training for green skills.

Other forms of private sector involvement outside the main institutional arrangements

- In Germany, the chemical industry established a sustainability initiative, Chemie. It is a joint institute at sector level with the sectoral industry association VCI (Verband der Chemischen Industrie e.V.), the trade union IG BCE (Industriegewerkschaft Bergbau, Chemie, Energie) and the respective employer association BAVC (Bundesarbeitgeberverband Chemie).

- In Spain, one environmental training programme is run by the company Acciona. It provided 34,618 training hours to workers in green and environmental subjects in 2015. It also provides courses with long duration in cooperation with the University of Alcalá in Madrid.

- In the UK, the Skills Academy for Sustainable Manufacturing and Innovation (SASMI) is based at Nissan's plant in the North-East of England.

Box 2.4	The involvement of the private sector in the institutional arrangements for the supply of green skills

Collaboration between companies to facilitate the provision of green skills

• In Germany, some inter-company vocational training centres (Überbetriebliche Bildungszentren) are focusing on environmental issues, and some have developed into multifunctional education centres. They are active in advanced training and continuing education and play a prominent role in promoting green skills and green technologies.

The involvement of universities in the provision of green skills

• Danish universities provide several programmes that are related to the green economy, including Bachelor programmes in environmental technology, and energy technology and planning, and Master programmes in water and environment, and environmental and natural resource economics. Danish universities have some discretion to design their own programmes as long as their programmes received accreditation from the Independent Accreditation Council.

• In France, the vocational licences (level II, Licence professionnelle) launched by universities based on identified skill needs now include new licences related to the green economy, such as Eco-design. French universities have some autonomy to launch new curricula, under the authorisation of the Ministry of Higher Education.

• The Estonian Environmental Strategy 2030 emphasizes that environmental education should be an integral part of all higher education curricula.

Engagement between universities and individual entrepreneurs to set-up targeted programmes

• In Estonia, the Estonian Ministry of the Environment, in cooperation with the Tallinn University of Technology and ÅFConsulting, launched specific training programmes for experienced engineers and specialists in energy and resource management in 2017 to meet the new skills requirements in industrial enterprises.

• French universities are involved in "campuses of professions and qualifications" programmes of which 10 programmes relate to the eco-industries. In Normandy, universities provide special courses in energy efficiency in several sectors, including photovoltaics and bioenergy. In the industrial Lorraine region, universities provide training in manufacturing of new fibres and materials based on bio-source polymers.

Source: CEDEFOP (2018).

2.3 Green skills: bringing the demand and supply together

Benchmarking international best practices of institutional arrangements for the identification of the demand for and supply of green skills could be useful for the design of training programmes aimed at developing skills and talent needed to support Ireland's innovation and the transition to a low-carbon economy.

A summary of recommendations for government policies to support the identification and provision of green skills put forward by ILO is presented in Box 2.5.

Box 2.5	Green skills: What can governments do?

a. Support the transitioning to more environmentally sustainable economies by reviewing skills development policies to ensure they support responsive training, capacity building and curricula.

b. Coordinate skills development policies and technical and vocational education and training systems with environmental policies and the greening of the economy; and consider concluding bipartite or tripartite agreements on skills' development.

c. Match supply and demand for skills through skills needs assessments, labour market information and core skills development, in collaboration with industry and training institutions.

d. Give high policy priority and allocate resources to the identification and anticipation of evolving skills needs and the review and alignment of occupational skills profiles and training programmes.

e. Encourage acquisition of both generic skills and skills in science, technology, engineering and mathematics and incorporation in curricula for basic training and lifelong learning.

Source: ILO (2011).

Taken together, the international evidence on the importance of skills to enable innovation and the transition to a low-carbon economy reviewed in the Introduction and the international best practices in advanced economies for institutional arrangements aimed at identifying and anticipating the demand for and supply of green skills summarised in this chapter provide useful insights for the analysis of skills needs to support enterprise innovation and Ireland's transition to a low-carbon economy.

3.

Skill Needs to Support Innovation and Ireland's Transition to a Low-Carbon Economy

This chapter examines skill needs in Ireland's enterprise sector to support innovation and the transition to a low-carbon economy. The analysis is based on data collected with an online survey and views of stakeholders put together during two workshops organised as part of this research study.

3.1 Evidence from online survey

3.1.1 Sampling Frame and Survey Questionnaire

The survey was carried out on a representative sample of enterprises. The sampling frame was designed using information from the Business Register[3] on the number of enterprises registered by industry, location (county), and size (micro, small, medium-sized, large). Details of the profile of respondents by sector, region and enterprise size are given in Tables A1-A3 in Appendix A.

The international evidence on challenges for the development of skills arising from the transition to a low-carbon economy discussed in Section 2 provided useful insights for the design of the survey questionnaire. The survey questionnaire[4] included a broad range of questions structured as follows:

- Awareness of and exposure to climate change challenges;
- Enterprise innovation activities including innovations with environmental benefits;

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[3] Results are based on the analysis of strictly controlled Research Microdata Files provided by Ireland's Central Statistics Office (CSO). The CSO does not take any responsibility for the views expressed or the outputs generated from this research.
[4] We would like to thank for their useful feedback on the survey questionnaire Tracey Donnery (Skillnet Ireland), Ken Stockil and Colm Gaskin (Central Solutions), Selina McCoy, Aisling Murray, Georgiana Mihut, Kelly de Bruin, Mert Yakut, Miguel Tovar Reaños, and Rachel Joyce (ESRI), Sean Ivory and Fernanda Boeira (Integral Research).

- Skill needs in the medium term to support enterprise innovation activities and the transition to a low-carbon economy;
- Existing training programmes and future training needs to develop the necessary skill sets;
- Suggestions for the development of programmes at national level to support the transition to a low-carbon economy (open question).

A pilot survey[5] was carried out before the launch of the survey. The online survey has been carried out by Integral Research, a specialised market research organisation. 100 completed responses (80 online responses and 20 interviews) which fulfilled the representativeness criteria and quality checks[6] were retained for analysis.

3.1.2 Awareness of and Exposure to Climate Change Challenges

Awareness of the European Green Deal

As shown in Fig. 3.1, the responses to the online survey indicate that the majority of enterprises (nearly 80% of all enterprises) are aware of the European Green Deal, the EU plan to achieve climate neutrality by 2050. Looking across enterprise groups, the highest awareness is for enterprises in the construction sector (88% of respondents), SMEs and enterprises in the industry sector (84% of respondents). The lowest awareness appears to be in the large enterprises group (42% of respondents).

Fig. 3.1 Awareness of the European Green Deal
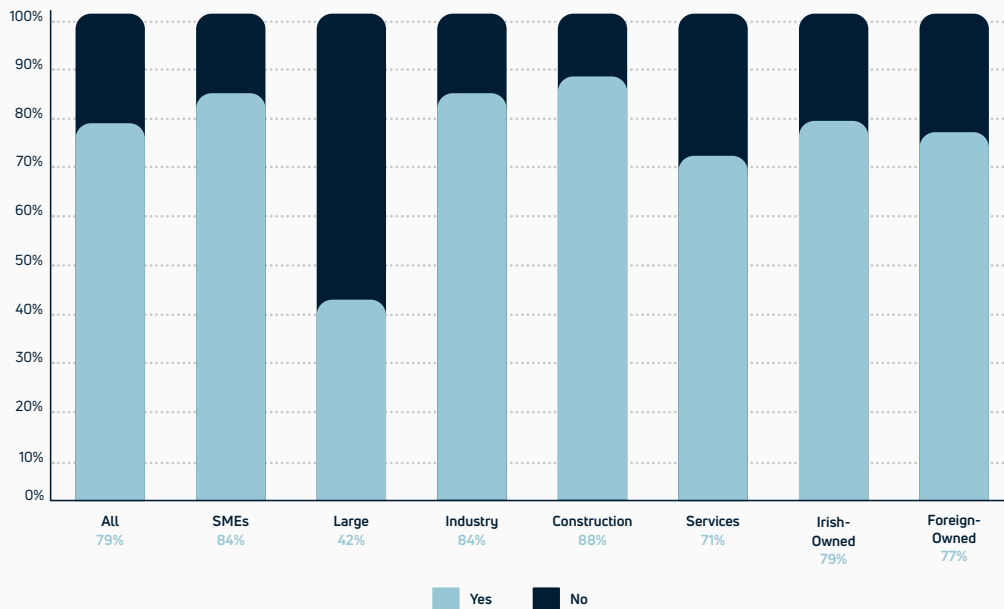
Source: Authors' calculations based on online survey.
Notes: Responses for all enterprises are weighted by enterprise size. Base: All respondents.
Q: Are you aware of the European Green Deal, the EU's plan to make Europe climate neutral by 2050?

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[6] Details on the quality checks implemented during the online survey are given in Appendix B.

Supporting the enterprise sector transition to a low-carbon economy

Fig. 3.2 shows that 59% of enterprises which are aware of the European Green Deal associate achieving carbon neutrality by 2050 with a positive impact in the medium term on enterprise performance while 31% of enterprises think the impact will be neutral. Only 10% of enterprises perceive achieving this goal as having a negative impact on their enterprises. Across enterprise groups, the largest positive impact in the

medium term is identified by respondents from large enterprises (80% of those aware of the European Green Deal) and lowest by respondents from the construction sector (57% of those aware of the European Green Deal). Almost one third of enterprises in the construction sector who are aware of the European Green Deal think it will impact negatively on their enterprises.

Fig. 3.2 Medium term impact of the goal of carbon-neutrality by 2050 on enterprise performance
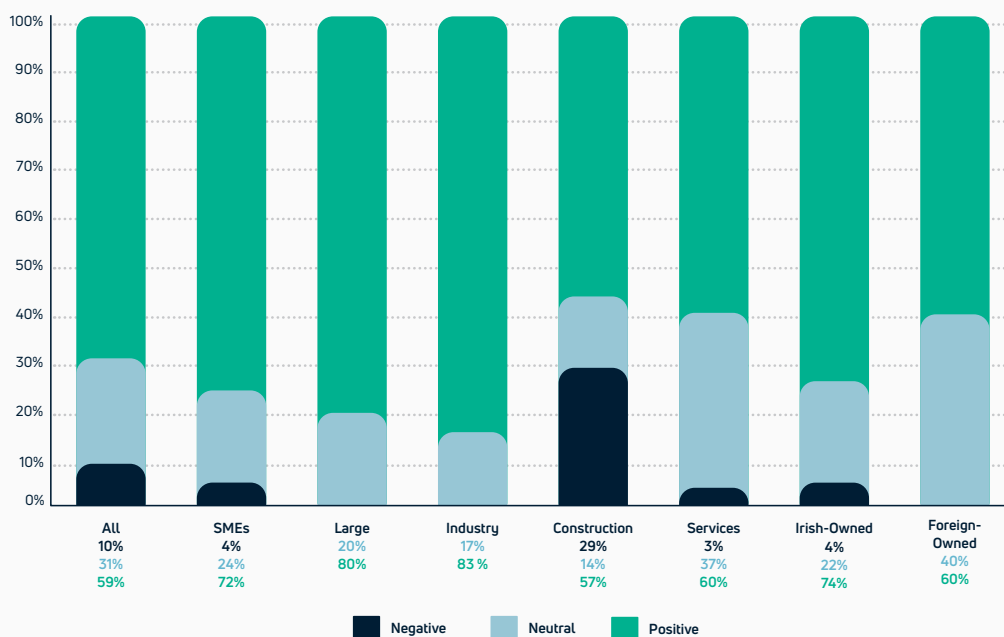
Source: Authors' calculations based on online survey.

Notes: Responses for all enterprises are weighted by enterprise size. Base: All respondents which are aware of the European Green Deal.

Q: How will this goal of achieving a net zero carbon economy impact on your enterprise in the next five years?

Awareness of Ireland's Climate Action Plan and challenges from its implementation

As shown in Fig. 3.3, a large proportion of enterprises (91%) were aware of Ireland's Climate Action Plan. Across enterprise groups, awareness is the highest in the construction sectors (all respondents), the SMEs group (92% of all respondents), and in the industry sector (90% of all respondents). Only 50% of respondents from large enterprises are aware of Ireland's Climate Action Plan.

Fig. 3.3 Awareness of Ireland's Climate Action Plan
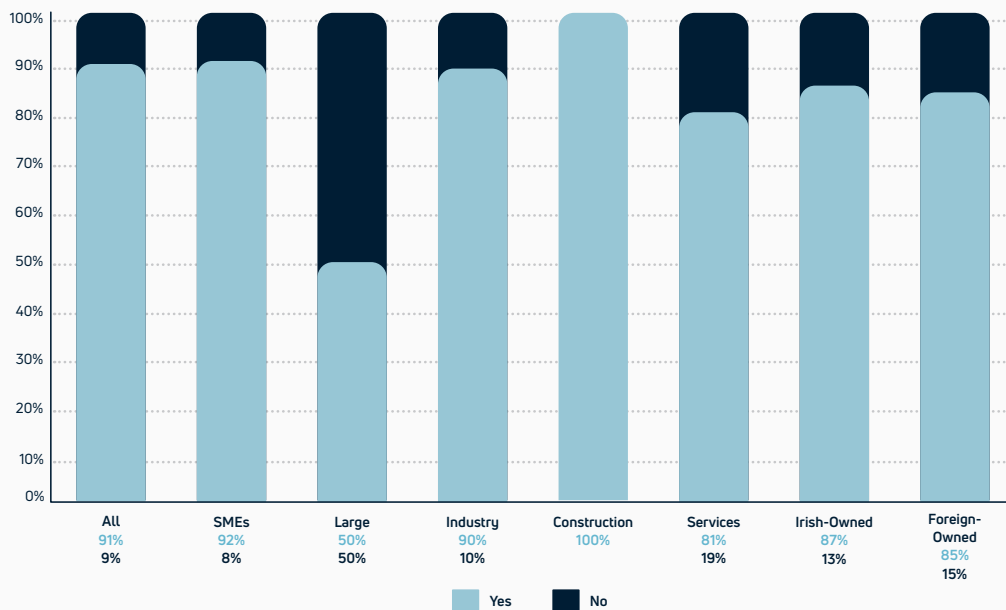
	All	SMEs	Large	Industry	Construction	Services	Irish-Owned	Foreign-Owned
Yes	91%	92%	50%	90%	100%	81%	87%	85%
No	9%	8%	50%	10%		19%	13%	15%

Yes ■ No ■

Source: Authors' calculations based on online survey.
Notes: Responses for all enterprises are weighted by enterprise size. Base: All respondents.
Q: Are you aware of Ireland's Climate Action Plan?

Challenges from the implementation of Ireland's Climate Action Plan

Respondents from enterprises that were aware of Ireland's Climate Change Plan were further asked to assess challenges they anticipate their enterprise would face in the medium term arising from the implementation of the Plan's measures. Fig. 3.4 summarises the responses for all enterprise groups. Developing new skills within the enterprise workforce appears to be the top challenge from the implementation of Ireland's Climate Action Plan enterprises face in the medium term (73% of enterprises which are aware of Ireland's Climate Action Plan). The next most important challenges identified by respondents are improving the way in which resources are used in their supply chain to reduce emissions (69% of enterprises) and improving energy efficiency of processes, buildings and transport (65% of all enterprises). Innovations in production,

Developing new skills within the enterprise workforce viewed as the top challenge

distribution, and marketing is a challenge for 55% of enterprises, while 48% of enterprises perceive replacing fossil fuel with renewables in production processes, building and transport as a challenge from the implementation of Ireland's Climate Action Plan.

Fig. 3.4 Challenges from the implementation of Ireland's Climate Action Plan – All enterprises

Challenge	Percentage
Developing new skills within your workforce	73%
Improving the use of resources in their supply chain to reduce emissions	69%
Improving energy efficiency of processes, buildings & transport	65%
innovations in production, distribution & marketing	55%
Replacing fossil fuel with renewables in production processes, buildings & transport	48%

Source: Authors' calculations based on online survey.
Notes: Responses are weighted by enterprise size. Base: All respondents which are aware of Ireland's Climate Action Plan.
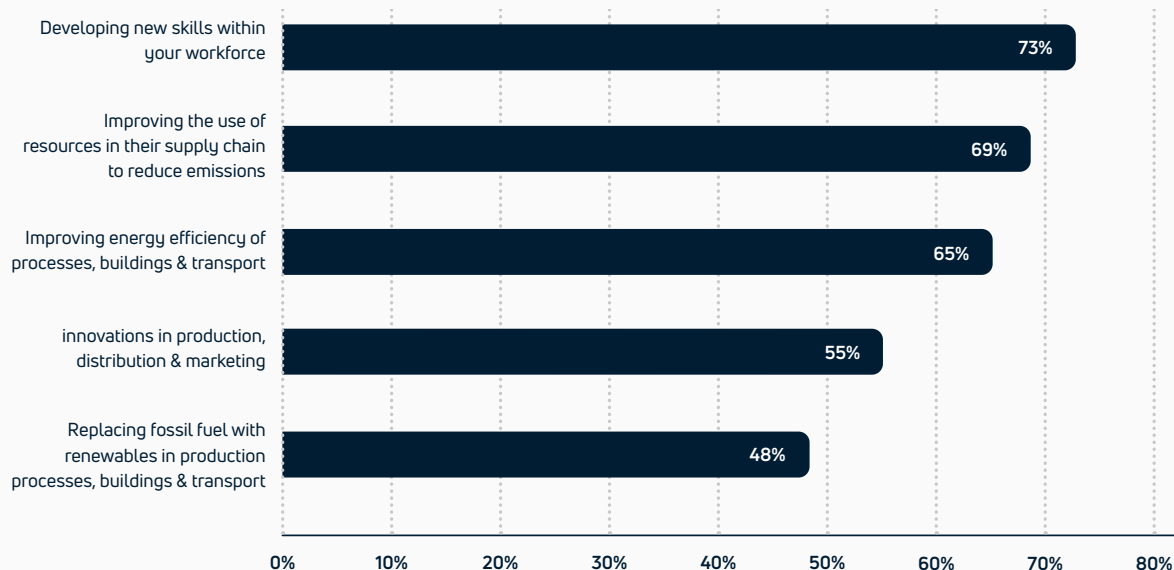Q: Over the next five years, will your enterprise face any challenges from the implementation of the following measures included in Ireland's Climate Action Plan?

As shown in Table 3.1, developing new skills within the enterprise workforce appears to be the main challenge from the implementation of Ireland's Climate Action plan for all enterprise groups (more than three quarters of all respondents). The next challenge faced by most enterprise groups identified by respondents is improving the way in which resources are used in their supply chain to reduce emissions (75% and more of respondents in all groups with the exception of enterprises in the service sector).

Table 3.1 Challenges from the implementation Ireland's Climate Action Plan – responses by enterprise groups

	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Developing new skills within your workforce	78%	100%	79%	82%	80%	76%	88%
Improving energy efficiency of processes, buildings and transport	79%	83%	82%	64%	84%	71%	88%
Replacing fossil fuel with renewables in production processes, buildings and transport	69%	83%	71%	64%	82%	59%	50%
Improving the way in which resources are used in their supply chain to reduce emissions	75%	100%	76%	82%	80%	71%	88%
Innovations in production, distribution, and marketing	63%	67%	63%	64%	64%	59%	75%

Source: Authors' calculations based on online survey.
Notes: Base: All respondents which are aware of Ireland's Climate Action Plan.
Q: Over the next five years, will your enterprise face any challenges from the implementation of the following measures included in Ireland's Climate Action Plan?

☐ less than 50%
☐ 50%-74%
■ 75% and more
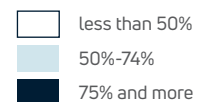
Measures required to address climate change that will affect enterprises in the next five years

Fig. 3.5 shows that a large proportion of enterprises anticipate that measures for the adjustment of production patterns required to address climate change will affect them in the medium term (63% of all enterprises).

Other measures expected to impact a large proportion of enterprises include compliance with regulations (59% of all enterprises); implementation of new technologies (55% of all enterprises), reducing carbon emissions (55% of all enterprises), and adjustment of consumption patterns (55% of all enterprises).

Fig. 3.5 Measures required to address climate change that will affect enterprises in the next five years – All enterprises
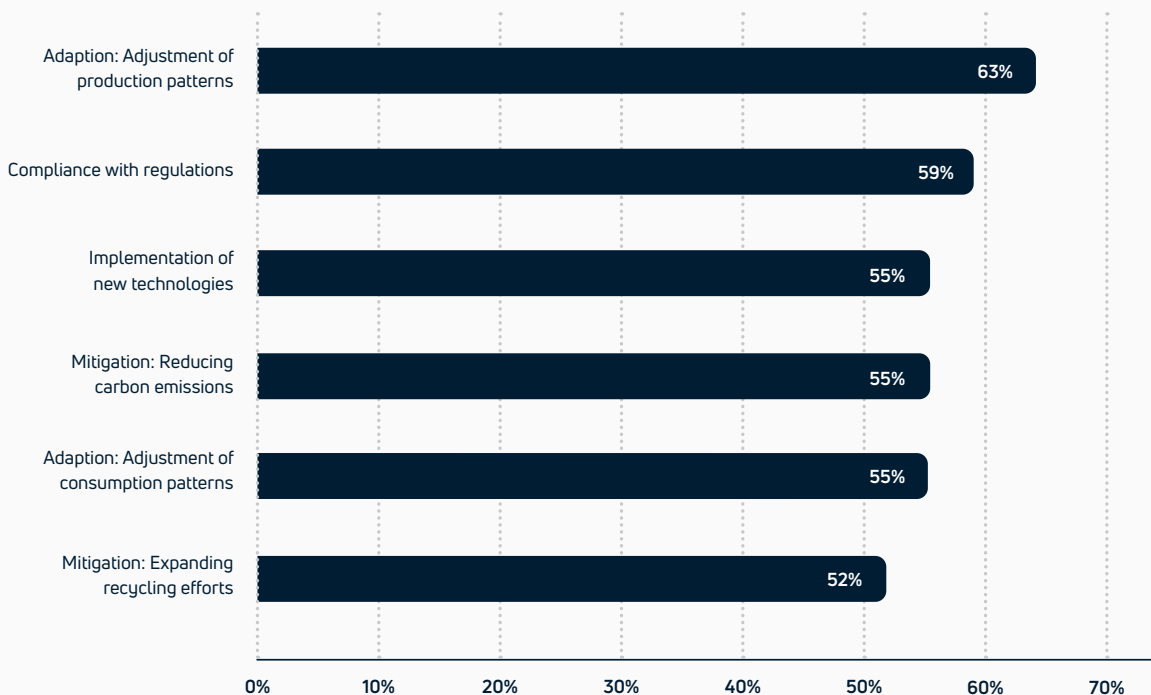
Measure	Percentage
Adaption: Adjustment of production patterns	63%
Compliance with regulations	59%
Implementation of new technologies	55%
Mitigation: Reducing carbon emissions	55%
Adaption: Adjustment of consumption patterns	55%
Mitigation: Expanding recycling efforts	52%

Source: Authors' calculations based on online survey.
Notes: Responses are weighted by enterprise size. Base: All respondents.
Q: Will any of the following measures required to address climate change affect your enterprise in the next five years?

Measures required to address climate change that will affect enterprises in the next five years –responses by enterprise groups

Looking at responses by enterprise groups (Table 3.2), SMEs appear to be most exposed to measures relating to adjustment of production patterns (73% of respondents) while large enterprises identify implementation of new technologies as the main set of measures to address climate change that will affect their activity in the medium term (75% of respondents).

Table 3.2 Measures required to address climate change that will affect enterprises in the next five years –responses by enterprise groups

	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Adaptation: Adjustment of production patterns	73%	67%	70%	85%	78%	62%	88%
Adaptation: Adjustment of consumption patterns	65%	58%	62%	77%	62%	64%	75%
Mitigation: Reducing carbon emissions	69%	67%	70%	62%	76%	62%	63%
Mitigation: Expanding recycling efforts	72%	58%	72%	54%	80%	60%	63%
Implementation of new technologies	68%	75%	69%	69%	70%	67%	75%
Compliance with regulations	68%	67%	68%	69%	74%	62%	63%

☐ less than 50%   ☐ 50%-74%   ☐ 75% and more

Source: Authors' calculations based on online survey.
Notes: Base: All respondents.
Q: Will any of the following measures required to address climate change affect your enterprise in the next five years?

For Irish-owned enterprises, the measures that will affect their activity most appear to be expanding recycling efforts (72% of respondents). Adjustment of production patterns is perceived as the top exposure for foreign-owned enterprises (85% of respondents). Enterprises in industry are most exposed to expanding recycling efforts (80% of respondents) while enterprises in the services sector are most exposed to implementation of new technologies (67% of respondents). Measures for the adjustment of production patterns appear to affect most of enterprises in the construction sector (88% of respondents).

3.1.3 The Impact of the Transition to a Low-Carbon Economy on Skill Needs

As shown in Fig. 3.6, the transition to a low-carbon economy will affect skill needs in a number of ways. Three quarters of enterprises anticipate that this impact will come through a shift of activities from less to more energy efficient and less polluting activities.

Enterprise predict a high impact on skills needs during transition to a low-carbon economy

Fig. 3.6 The impact of the transition to a low-carbon economy on skill needs – All enterprises
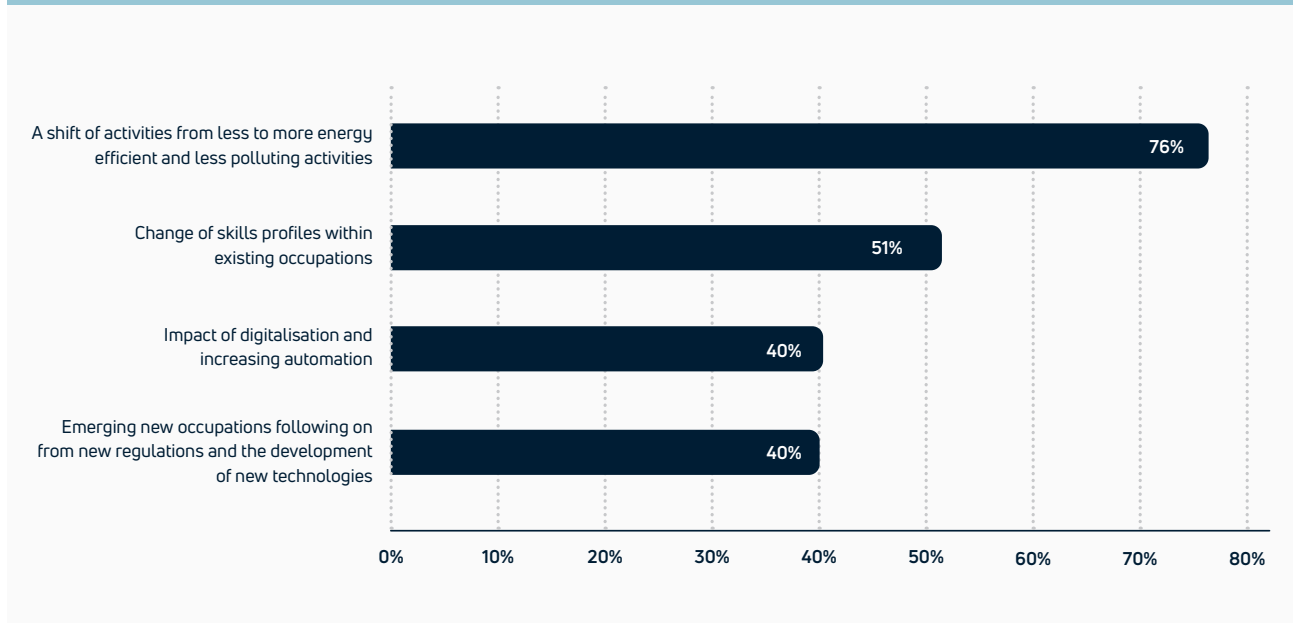
Category	Percentage
A shift of activities from less to more energy efficient and less polluting activities	76%
Change of skills profiles within existing occupations	51%
Impact of digitalisation and increasing automation	40%
Emerging new occupations following on from new regulations and the development of new technologies	40%

Source: Authors' calculations based on online survey.

Notes: Responses are weighted by enterprise size. Base: All respondents.

Q: Will the transition to a low-carbon economy affect skill needs in your enterprise in the next five years due to any of the following?

The impact of the transition to a low-carbon economy on skill needs – responses by enterprise group

The responses by enterprise group summarised in Table 3.3 indicate that for both SMEs and large enterprises the impact of the transition to a low-carbon economy on skills needs is expected to come mainly through a shift of activities from less to more energy efficient and less polluting activities. Emerging new occupations following on from new regulations and the development of new technologies has been identified by large enterprises as an equally important channel for the impact of the transition to a low-carbon economy on skill needs.

Table 3.3 The impact of the transition to a low-carbon economy on skill needs – by enterprise group

	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
A shift of activities from less to more energy efficient and less polluting activities	81%	75%	78%	92%	90%	64%	100%
Emerging new occupations following on from new regulations and the development of new technologies	65%	75%	67%	62%	78%	50%	75%
Impact of digitalisation and increasing automation	65%	50%	61%	77%	66%	60%	63%
Change of skills profiles within existing occupations	64%	42%	62%	54%	60%	64%	50%

☐ less than 50%	☐ 50%-74%	■ 75% and more

Source: Authors' calculations based on online survey.
Notes: Base: All respondents.
Q: Will the transition to a low-carbon economy affect skill needs in your enterprise in the next five years due to any of the following?

Skill needs in the medium term to support enterprise innovation activities and the transition to a low-carbon economy

Fig. 3.7 shows that the top skill sets needed in the medium term to support the transition to a low-carbon economy identified by enterprises include: waste management skills (78% of all enterprises); corporate sustainability strategy skills (75% of all enterprises); carbon management skills (67% of all enterprises); and sustainable finance skills (67% of all enterprises).

Fig. 3.7 Skill needs in the medium term to support the transition to a low carbon economy – All enterprises

Skill	Percentage
Waste management skills	78%
Corporate sustainability strategy skills	75%
Carbon management skills	67%
Sustainable finance skills	67%
Water management skills	64%
Energy-efficiency design skills	60%
Sustainable transport & logistics skills	52%
Building & retrofits skills	51%
Green procurement skills	51%

Source: Authors' calculations based on online survey.
Notes: Responses are weighted by enterprise size. Base: All respondents.
Q: Which of the following skills could help your enterprise to support Ireland's transition to a low-carbon economy in the next five years?

The responses summarised in Table 3.4 indicate that the full range of green skills analysed were identified as needed in the medium term by over half of respondents across all enterprise groups. A broad range of green skills are needed in the medium term for over three quarters of enterprises across all enterprises groups. The most needed green skills vary across enterprise groups. Corporate sustainability strategy skills tops the range of green skills needed for all enterprise groups with the exception of large enterprises and enterprises in the industry and services sectors. Carbon management skills are the most needed green skills for large enterprises and Irish-owned enterprises while waste management skills tops the green skill needed for enterprises in the services sector.

Table 3.4 Skill needs in the medium term to support the transition to a low carbon economy – by enterprise group

Green skills	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Corporate sustainability strategy skills	82%	75%	79%	92%	84%	74%	100%
Carbon management skills	77%	92%	79%	77%	86%	74%	63%
Waste management skills	75%	75%	75%	77%	76%	76%	63%
Energy-efficiency design skills	76%	83%	77%	77%	82%	69%	88%
Water management skills	78%	50%	78%	54%	82%	69%	63%
Building and retrofits skills	65%	50%	63%	62%	70%	55%	63%
Sustainable transport and logistics skills	69%	58%	69%	62%	72%	64%	63%
Green procurement skills	65%	67%	66%	62%	76%	55%	50%
Sustainable finance skills	72%	67%	69%	85%	76%	60%	100%

☐ less than 50% ☐ 50%-74% ■ 75% and more

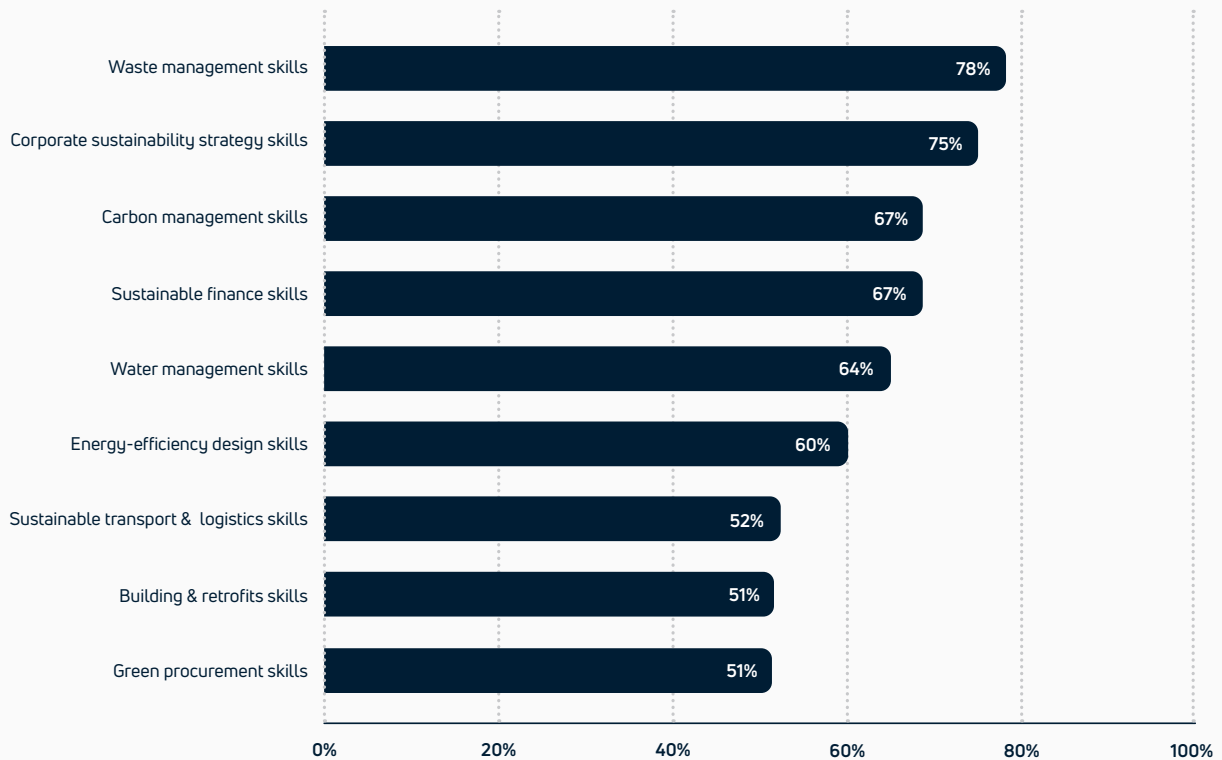Source: Authors' calculations based on online survey.
Notes: Base: All respondents.
Q: Which of the following skills could help your enterprise to support Ireland's transition to a low-carbon economy in the next five years?

Skill needs in the medium term to support enterprise innovations with environmental benefits

Fig. 3.8 shows that the top skill sets needed in the medium term to support enterprise innovations with environmental benefits include climate change and sustainability strategy skills (84% of all enterprises); marketing skills (70% of all enterprises); and financial skills relating to investment and access to finance (67% of all enterprises).

Fig. 3.8 Skill needs in the medium term to support enterprise innovations with environmental benefits – All enterprises
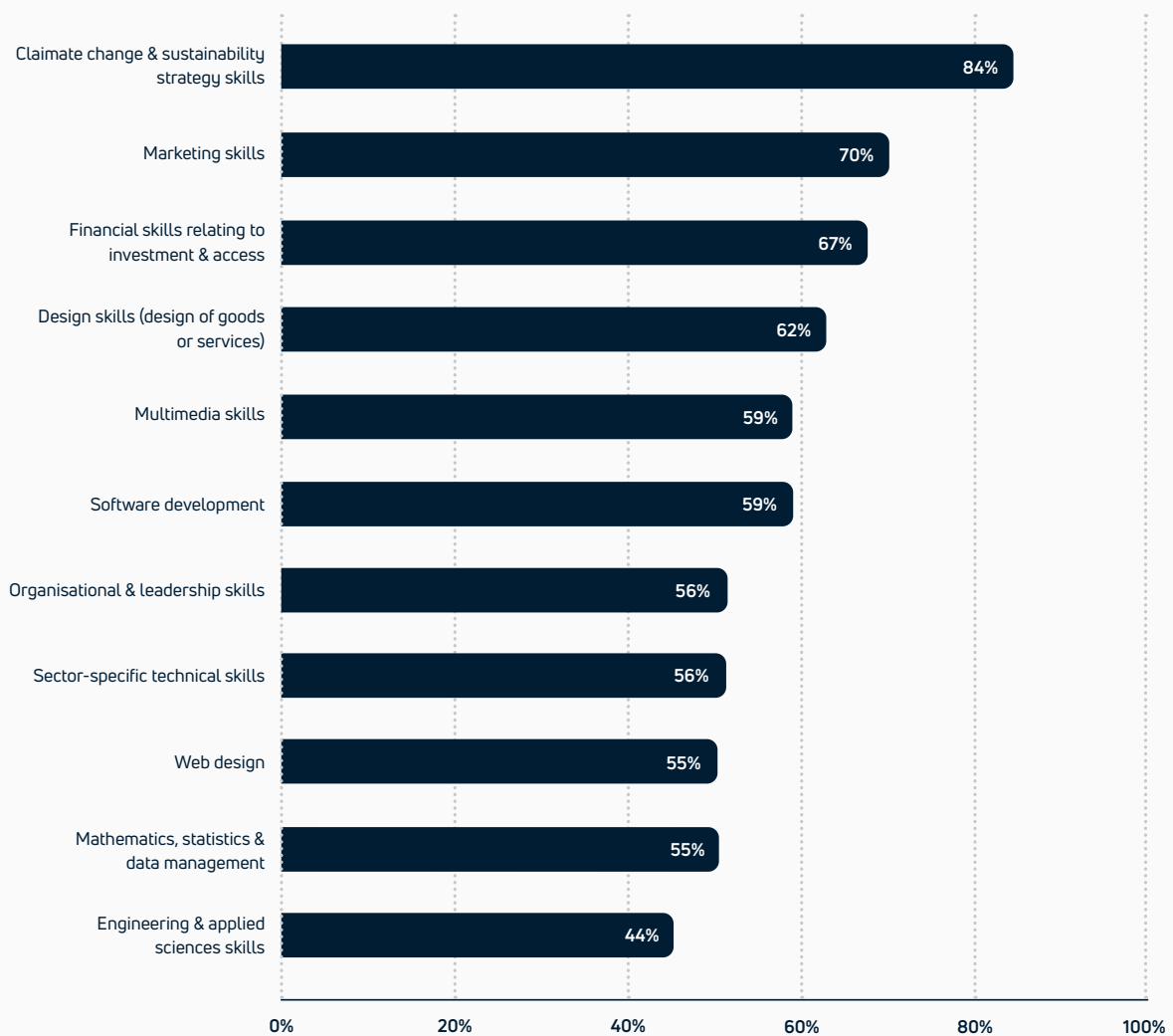
Source: Authors' calculations based on online survey.
Notes: Responses are weighted by enterprise size. Base: All respondents.
Q: Which of the following skills could help improve and support your enterprise's innovation activities with environmental impacts over the next five years?

Looking across enterprise groups (Table 3.5), climate change and sustainability strategy skills to support green innovation were identified as needed in the medium term by over three quarters of respondents in all groups with the exception of large enterprises. Three quarters of respondents in large enterprises identified a broader range of skills to support green innovation which are needed in the medium term: sector-specific technical skills; web design;

mathematics, statistics and data management; organisational and leadership skills. Financial skills relating to investment and access to finance together with climate change and sustainability strategy skills are the most needed green innovation skills for foreign-owned respondents. Financial skills relating to investment and access to finance were identified as the most needed green innovation skills for respondents in the construction sector.

Table 3.5 Skill needs in the medium term to support enterprise innovations with environmental benefits – responses by enterprise group

Green innovation skills	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Climate change and sustainability strategy skills	91%	67%	89%	85%	96%	81%	75%
Sector-specific technical skills	69%	75%	74%	46%	72%	74%	38%
Design skills (design of goods or services)	63%	58%	63%	54%	66%	55%	75%
Software development	63%	58%	61%	69%	70%	52%	63%
Web design	63%	75%	64%	62%	78%	48%	63%
Engineering and applied sciences skills	66%	67%	66%	69%	80%	52%	50%
Mathematics, statistics and data management skills	65%	75%	66%	69%	72%	57%	75%
Organisational and leadership skills	70%	75%	72%	62%	74%	69%	63%
Marketing skills	70%	58%	71%	54%	74%	64%	63%
Multimedia skills	69%	67%	72%	46%	80%	62%	38%
Financial skills for investment and access to finance	74%	58%	70%	85%	70%	71%	88%

☐ less than 50%　　☐ 50%-74%　　■ 75% and more

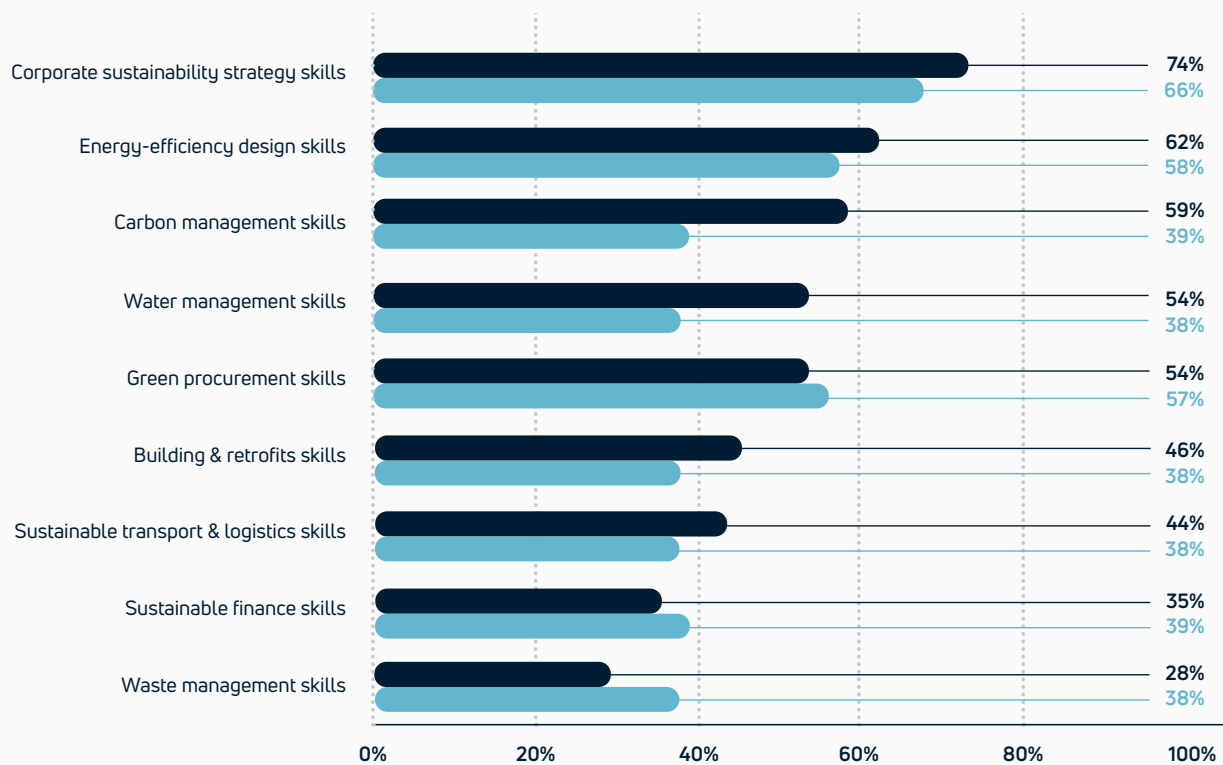Source: Authors' calculations based on online survey.
Notes: Base: All respondents.
Q: Which of the following skills could help improve and support your enterprise's innovation activities with environmental impacts over the next five years?

Fig. 3.9 summarises the responses to questions relating to the demand for and supply of skills across all enterprise groups. In terms of recruiting plans in the medium term, corporate sustainability skills is the top skill set among the green skills sets analysed (74% of all enterprises). The next most demanded skills are energy-efficiency design (62% of all enterprises) and carbon management (59% of all enterprises). Green skills which are most difficult to recruit in the medium term are corporate sustainability strategy skills (66% of all enterprises), energy-efficiency design skills (58% of all enterprise), and green procurement skills (57% of all enterprises).

Fig. 3.9 Green skills: Medium term recruitment plans and difficulties – All enterprises

Skill	Recruitment Plans	Recruitment Difficulties
Corporate sustainability strategy skills	74%	66%
Energy-efficiency design skills	62%	58%
Carbon management skills	59%	39%
Water management skills	54%	38%
Green procurement skills	54%	57%
Building & retrofits skills	46%	38%
Sustainable transport & logistics skills	44%	38%
Sustainable finance skills	35%	39%
Waste management skills	28%	38%

■ Recruitment Plans   ■ Recruitment Difficulties

Source: Authors' calculations based on online survey.
Notes: Responses are weighted by enterprise size. Base: All respondents.
Q: Over the next two to five years, does your enterprise plan to recruit employees with any of the following skills that could help to support Ireland's transition to a low-carbon economy?
Q: Did your enterprise experience difficulties in recruiting employees with any of the following skills that could help to support Ireland's transition to a low-carbon economy?

Figure 3.10 links responses on plans to recruit employees with green skills (a proxy for skills demand) with recruitment difficulties in this area (a proxy for skills supply). The following patterns emerge:

Skills with high demand and low supply/ high recruitment difficulty: Corporate sustainability strategy skills; Energy-efficiency design skills; Green procurement skills.

Skills with high demand and high supply/ low recruitment difficulty: Carbon management skills; Water management skills.

Skills with low demand and high-supply/ low recruitment difficulty: Waste management skills; Building and retrofits skills; Sustainable transport and logistics skills; Sustainable finance skills.

Fig. 3.10 Green skills: Recruitment plans vs recruitment difficulties
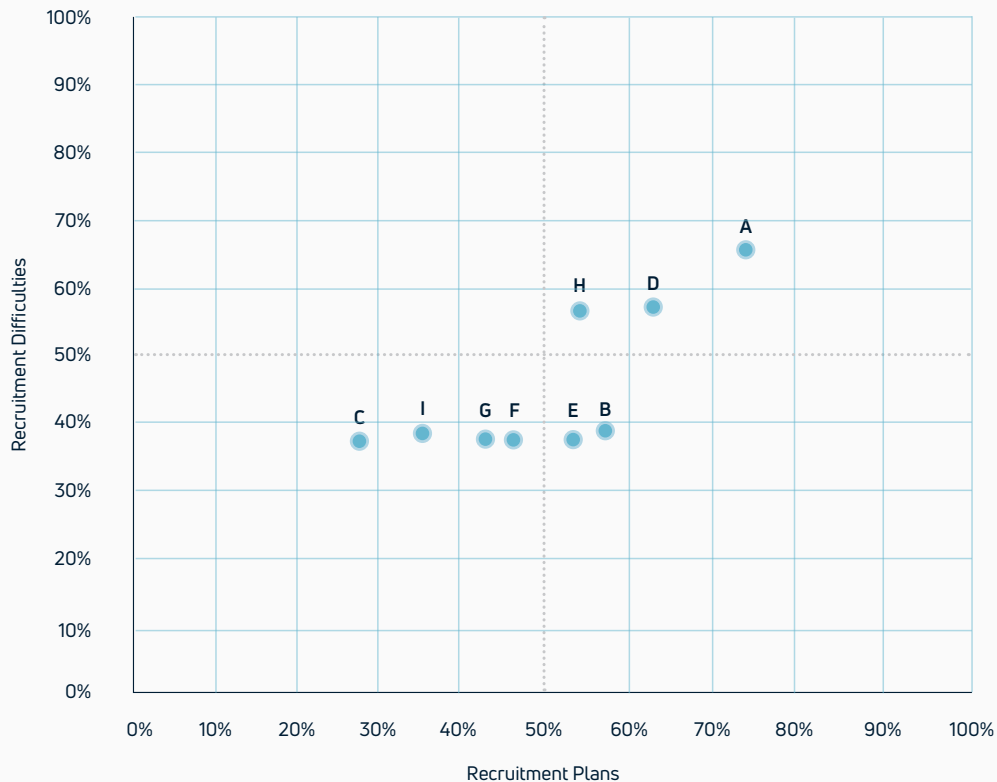
Source: Authors' calculations based on online survey.

Notes: Responses are weighted by enterprise size. Base: All respondents.

A: Corporate sustainability strategy skills; B: Carbon management skills; C: Waste management skills; D: Energy-efficiency design skills; E: Water management skills; F: Building and retrofits skills; G: Sustainable transport and logistics skills; H: Green procurement skills; I: Sustainable finance skills; J: Sector-specific skills.

Q: Over the next two to five years, does your enterprise plan to recruit employees with any of the following skills that could help to support Ireland's transition to a low-carbon economy?

Q: Did your enterprise experience difficulties in recruiting employees with any of the following skills that could help to support Ireland's transition to a low-carbon economy?

Looking at responses across enterprise groups (Table 3.6), over half of respondents from SMEs and Irish-owned firms as well as respondents from enterprises in the industry sector plan to recruit in the medium term the full range of green skills analysed. Over three quarters of respondents in the industry and construction sectors plan to recruit employees with corporate sustainability strategy skills, energy-efficiency design skills, and green procurement skills. Respondents from large enterprises identify sustainable finance skills as the top green skills set for recruitment in the medium term.

Corporate sustainability strategy skills is the top green skills set for recruitment plans of respondents from Irish-owned enterprises, SMEs and from the services and construction sector

Table 3.6 Demand for green skills: Medium term recruitment plans – responses by enterprise group

Green skills	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Corporate sustainability strategy skills	73%	58%	71%	69%	78%	57%	100%
Carbon management skills	67%	58%	68%	54%	86%	43%	63%
Waste management skills	59%	42%	62%	23%	72%	43%	38%
Energy-efficiency design skills	66%	42%	66%	46%	76%	45%	75%
Water management skills	59%	42%	60%	38%	70%	43%	50%
Building and retrofits skills	56%	50%	55%	54%	62%	45%	63%
Sustainable transport and logistics skills	63%	50%	66%	31%	72%	48%	63%
Green procurement skills	60%	58%	59%	69%	76%	38%	75%
Sustainable finance skills	59%	75%	62%	54%	74%	45%	63%

☐ less than 50%   ▨ 50%-74%   ■ 75% and more

Source: Authors' calculations based on online survey.
Notes: Base: All respondents.
Q: Over the next two to five years, does your enterprise plan to recruit employees with any of the following skills that could help to support Ireland's transition to a low-carbon economy?

Looking at responses relating to the supply of green skills by enterprise groups (Table 3.7), enterprises in the industry and construction sectors appear to be most exposed to difficulties in the medium term in relation to recruiting employees with green skills. Over 50% of respondents from the industry sector identify recruitment difficulties for all green skills with the exception of energy-efficiency design skills (48% of respondents) and building and retrofits skills (46% of respondents). All respondents in the construction sector report recruitment difficulties for employees with energy-efficiency design skills and 75% of respondents for employees with corporate sustainability strategy skills. 50% or more of respondents in the construction sector report recruitment difficulties for all the other green skills sets with the exception of water management skills (38% of respondents).

Table 3.7 Supply of green skills: Medium term recruitment difficulties – responses by enterprise group

Green skills	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Corporate sustainability strategy skills	58%	42%	56%	54%	62%	45%	75%
Carbon management skills	48%	50%	49%	38%	58%	36%	50%
Waste management skills	45%	42%	45%	46%	50%	38%	50%
Energy-efficiency design skills	49%	25%	46%	46%	48%	33%	100%
Water management skills	43%	50%	45%	38%	56%	31%	38%
Building and retrofits skills	45%	25%	44%	38%	46%	36%	63%
Sustainable transport and logistics skills	43%	42%	45%	31%	50%	33%	50%
Green procurement skills	47%	50%	45%	62%	50%	40%	63%
Sustainable finance skills	51%	33%	53%	23%	56%	38%	63%

■ less than 50%   ■ 50%-74%   ■ 75% and more

Source: Authors' calculations based on online survey.
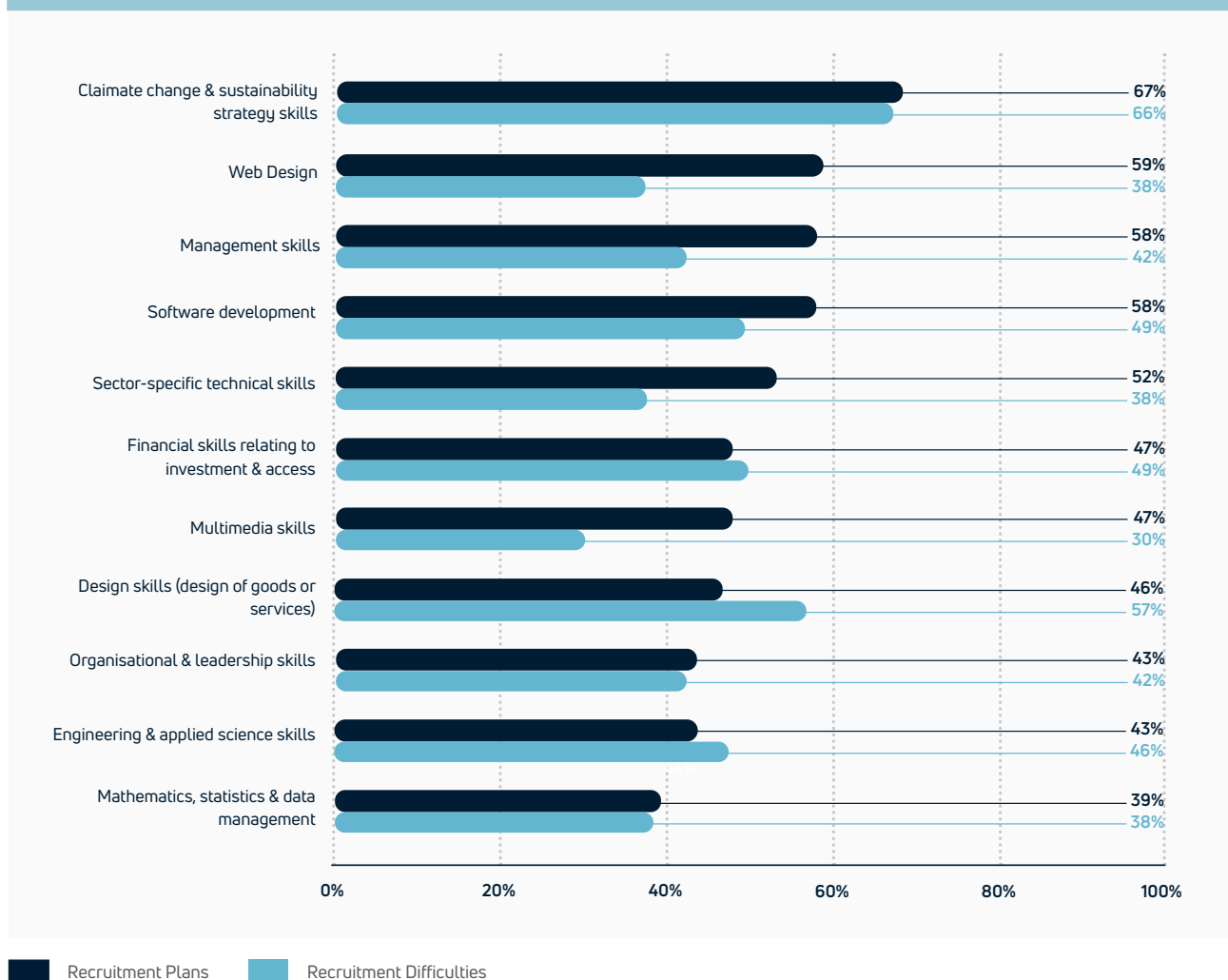Notes: Base: All respondents.
Q: Did your enterprise experience difficulties in recruiting employees with any of the following skills that could help to support Ireland's transition to a low-carbon economy?

Demand for and supply of green innovation skills

Fig. 3.11 summarises the responses on the demand for and supply of skills needed to support green innovation across all enterprise groups. Among the skills sets that could support innovations with environmental benefits, those which are most demanded in the medium term as per recruitment plans are climate change and sustainability strategy skills (67% of all enterprises), digital skills (web design -59% of all enterprises; software development- 58% of all enterprises), and marketing skills (58% of all enterprises). While climate change and sustainability strategy skills is in high-demand, 66% of enterprises reported having had difficulties to recruit employees with this skill set. The next most difficult innovation skill set to recruit appears to be skills for the design of goods or services (5% of enterprises).

Fig 3.11 Green innovation skills: Medium term recruitment plans and difficulties – All enterprises

Skill	Recruitment Plans	Recruitment Difficulties
Claimate change & sustainability strategy skills	67%	66%
Web Design	59%	38%
Management skills	58%	42%
Software development	58%	49%
Sector-specific technical skills	52%	38%
Financial skills relating to investment & access	47%	49%
Multimedia skills	47%	30%
Design skills (design of goods or services)	46%	57%
Organisational & leadership skills	43%	42%
Engineering & applied science skills	43%	46%
Mathematics, statistics & data management	39%	38%

■ Recruitment Plans ■ Recruitment Difficulties

Source: Authors' calculations based on online survey.
Notes: Responses are weighted by enterprise size. Base: All respondents.
Q: Over the next two to five years, does your enterprise plan to recruit employees with any of the following skills that could help to support your enterprise green innovations?
Q: Did your enterprise experience difficulties in recruiting employees with any of the following skills that could help to support your enterprise green innovations?

Green innovation skill needs:
Recruitment plans vs recruitment difficulties

Fig. 3.12 combines responses on recruitment plans (a proxy for skills demand) with recruitment difficulties (a proxy for skills supply) with respect to green innovation skills. The following patterns emerge:

Skills with high-demand and low supply/high recruitment difficulty: Climate change and sustainability strategy skills.

Skills with low-demand and low-supply/ high recruitment difficulty: C: Design skills.

Skills with high-demand and high supply/low recruitment difficulty: Sector-specific technical skills; Software development; Web design; Marketing skills.

Skills with low demand and high-supply/low recruitment difficulty: Engineering and applied science skills; Mathematics, statistics and data management skills; Organisational and leadership skills; Multimedia skills; Financial skills relating to investment and access to finance.

Fig. 3.12 Green innovation skills: Recruitment plans vs recruitment difficulties

Source: Authors' calculations based on online survey.
Notes: Responses are weighted by enterprise size. Base: All respondents.
A: Climate change and sustainability strategy skills; B: Sector-specific technical skills; C: Design skills; D: Software development; E: Web design; F: Engineering and applied science skills; G: Mathematics, statistics and data management skills; H: Organisational and leadership skills; I: Marketing skills; J: Multimedia skills; K: Financial skills relating to investment and access to finance.
Q: Over the next two to five years, does your enterprise plan to recruit employees with any of the following skills that could help to support your enterprise green innovations?
Q: Did your enterprise experience difficulties in recruiting employees with any of the following skills that could help to support your enterprise green innovations?

Looking at responses across enterprises groups (Table 3.8), at least 50% of respondents from enterprises which are SMEs, large, Irish-owned and in the industry sector reported plans to recruit in the medium term the full range of green innovation skills. Climate change and sustainability strategy skills were identified as being most demanded by respondents from SMEs, Irish-owned enterprises and from enterprises in the industry and construction sectors. Sector-specific technical skills are most demanded in large enterprises and in the services sector.

Climate change and sustainability strategy skills will be most in demand among the sets of green innovation skills

Table 3.8 Green innovation skills: Medium term recruitment difficulties – responses by enterprise group

Green innovation skills	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Climate change and sustainability strategy skills	75%	50%	74%	62%	84%	52%	100%
Sector-specific technical skills	66%	83%	69%	62%	74%	64%	50%
Design skills (design of goods or services)	55%	67%	56%	54%	64%	45%	63%
Software development	61%	58%	60%	69%	66%	55%	63%
Web design	64%	67%	63%	69%	72%	55%	63%
Engineering and applied sciences skills	55%	50%	55%	46%	66%	38%	63%
Mathematics, statistics and data management skills	53%	67%	56%	46%	62%	50%	38%
Organisational and leadership skills	64%	67%	64%	62%	72%	55%	63%
Marketing skills	63%	75%	66%	54%	68%	55%	88%
Multimedia skills	58%	58%	61%	38%	74%	45%	25%
Financial skills relating to investment and access to finance	60%	75%	61%	69%	66%	57%	63%

	less than 50%		50%-74%		75% and more

Source: Authors' calculations based on online survey.

Notes: Base: All respondents.

Q: Over the next two to five years, does your enterprise plan to recruit employees with any of the following skills that could help to support your enterprise green innovations?

In terms of the supply of green innovation skills (Table 3.9), corporate change and sustainability strategy skills is the innovation skills set most difficult to recruit as identified by at least 50% of respondents in all enterprise groups with the exception of respondents from large enterprises. Sector-specific technical skills are most difficult to recruit by large enterprises (75% of respondents).

Table 3.9 Green innovation skills: Medium term recruitment difficulties – responses by enterprise group

Green innovation skills	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Climate change and sustainability strategy skills	63%	42%	60%	62%	64%	50%	88%
Sector-specific technical skills	44%	75%	52%	23%	54%	38%	63%
Design skills (design of goods or services)	47%	42%	44%	62%	52%	33%	75%
Software development	42%	58%	41%	62%	40%	45%	63%
Web design	40%	50%	40%	46%	42%	36%	63%
Engineering and applied sciences skills	48%	50%	45%	69%	54%	40%	50%
Mathematics, statistics and data management skills	44%	50%	45%	46%	52%	40%	25%
Organisational and leadership skills	47%	25%	44%	46%	46%	38%	63%
Marketing skills	42%	33%	40%	46%	44%	36%	50%
Multimedia skills	35%	50%	38%	31%	44%	31%	25%
Financial skills relating to investment and access to finance	44%	25%	41%	46%	48%	33%	50%

□ less than 50%   ▨ 50%-74%   ■ 75% and more

Source: Authors' calculations based on online survey.
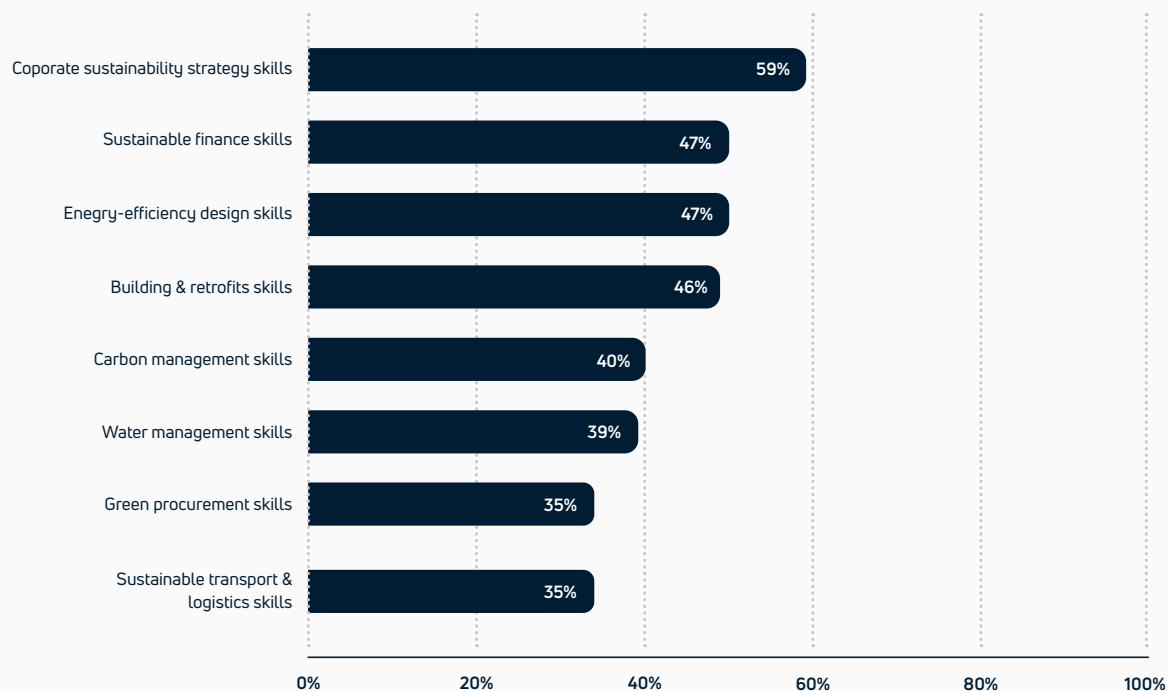Notes: Base: All respondents.
Q: Did your enterprise experience difficulties in recruiting employees with any of the following skills that could help to support your enterprise green innovations?

3.1.4 Training needs in the medium term to support innovation and the transition to a low-carbon economy

As shown in Fig. 3.13, among the analysed green skills to support Ireland's transition to a low economy, training in corporate sustainability strategy skills is the most needed in the medium term (59% of all enterprises). The next most needed training programmes are those on sustainable finance skills and energy-efficiency design skills (47% of all enterprises).

Fig. 3.13 Training needs in the medium term to support the transition to a low-carbon economy – All enterprises

Skill	%
Coporate sustainability strategy skills	59%
Sustainable finance skills	47%
Enegry-efficiency design skills	47%
Building & retrofits skills	46%
Carbon management skills	40%
Water management skills	39%
Green procurement skills	35%
Sustainable transport & logistics skills	35%

Source: Authors' calculations based on online survey.
Notes: Responses are weighted by firm size. Base: All respondents.
Q: Over the next five years, does your enterprise envisage the need for training to develop the following skills of employed persons?

Corporate sustainability strategy skills have been identified as required by over 50% of people surveyed

As shown in Table 3.10, the need for training in corporate sustainability strategy skills has been identified by over 50% of respondents from all enterprise groups (78% of respondents from the industry sector; 75% of respondents from the construction sector; 69% of respondents from SMEs and Irish-owned enterprises).

Table 3.10 Training needs in the medium term to support the transition to a low-carbon economy – responses by enterprise groups

Green skills	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Corporate sustainability strategy skills	69%	58%	69%	62%	78%	55%	75%
Carbon management skills	61%	50%	66%	23%	76%	48%	25%
Waste management skills	52%	50%	53%	46%	66%	36%	50%
Energy-efficiency design skills	56%	58%	55%	62%	64%	45%	63%
Water management skills	57%	50%	57%	46%	70%	40%	50%
Building and retrofits skills	56%	42%	56%	38%	68%	40%	38%
Sustainable transport and logistics skills	56%	42%	55%	46%	66%	40%	50%
Green procurement skills	57%	50%	57%	46%	68%	43%	50%
Sustainable finance skills	58%	50%	56%	62%	72%	36%	75%

☐ less than 50%   ☐ 50%-74%   ■ 75% and more

Source: Authors' calculations based on online survey.
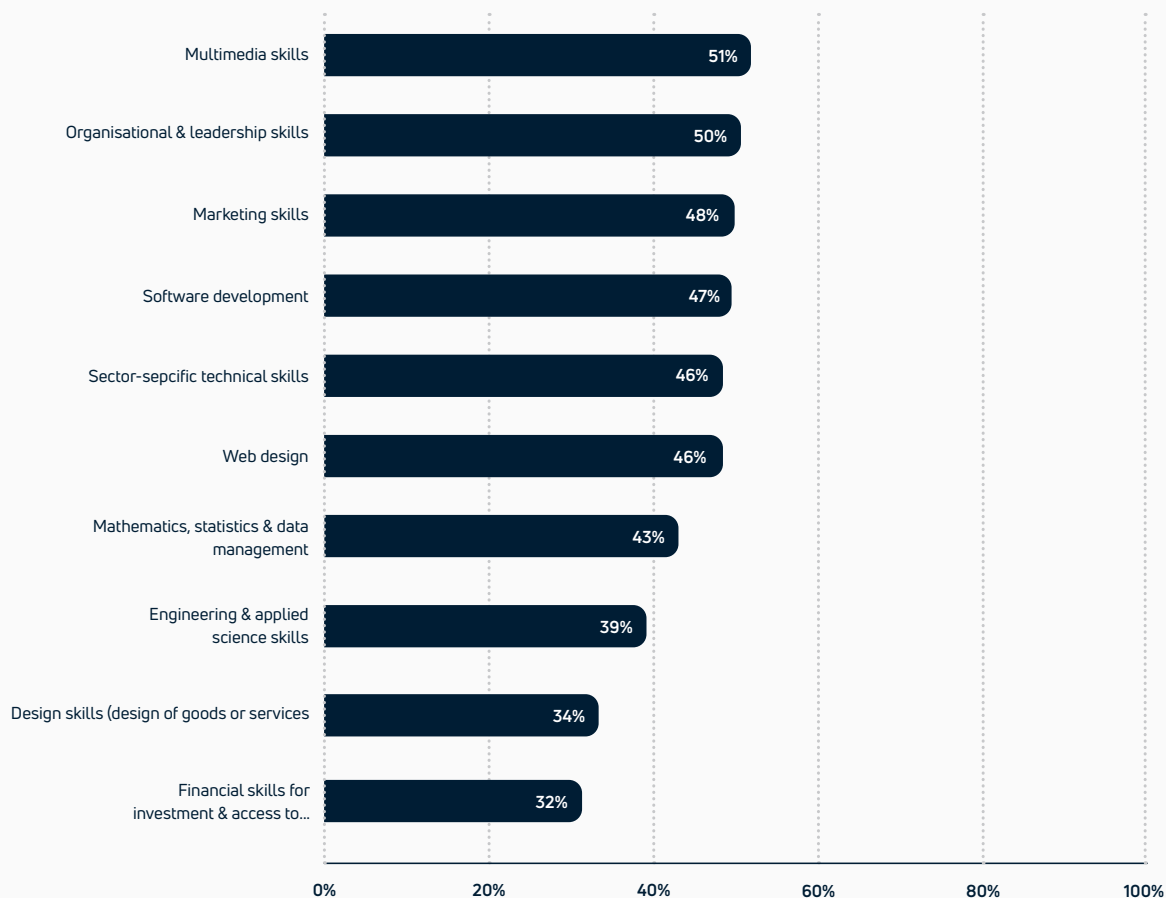Notes: Base: All respondents.
Q: Over the next five years, does your enterprise envisage the need for training to develop the following skills of employed persons?

Training needs in the medium term to support green innovations

Fig. 3.14 shows responses relating to training needs for green innovation skills the in medium term. Training on multimedia skills has been identified as the most demanded (51% of all enterprises). The next most demanded training programmes are on organisational and leadership skills (50% of all enterprises) and marketing skills (48% of all enterprises).

Fig. 3.14 Training needs in the medium term to support green innovations – All enterprises

Skill	Percentage
Multimedia skills	51%
Organisational & leadership skills	50%
Marketing skills	48%
Software development	47%
Sector-sepcific technical skills	46%
Web design	46%
Mathematics, statistics & data management	43%
Engineering & applied science skills	39%
Design skills (design of goods or services	34%
Financial skills for investment & access to…	32%

Source: Authors' calculations based on online survey.
Notes: Responses are weighted by enterprise size. Base: All respondents.
Q: Over the next five years, does your enterprise envisage the need for training to develop the following skills of employed persons?

Training needs in the medium term to support green innovations – responses by enterprise groups

Table 3.11 shows a broad range of training needs related to green innovation skills identified across enterprise groups. Across all enterprises groups, those identified by at least 50% of respondents include training on software development; organisational and leadership skills; multimedia skills; web design (all groups with the exception enterprises in the services sector); engineering and applied sciences skills (all groups with the exception of enterprises in the services sector); mathematics, statistics, and data management skills (all groups with the exception of enterprises in the construction sector); marketing skills (all with the exception of enterprises in the construction sector). At least 50% of respondents from SMEs, Irish-owned enterprises and enterprises in the industry sector identify training needs in all green innovation skills analysed with the exception of design skills (47% of respondents from SMEs; 49% of respondents from Irish- owned enterprises; 46% of respondents from the industry sector).

Table 3.11 Training needs in the medium term to support green innovations – responses by enterprise groups

	SMEs	Large	Irish-owned	Foreign-owned	Industry	Services	Construction
Sector-specific technical skills	58%	50%	59%	46%	62%	57%	25%
Design skills (design of goods or services)	47%	58%	49%	38%	46%	50%	50%
Software development	59%	50%	57%	62%	60%	57%	50%
Web design	53%	58%	53%	62%	64%	40%	63%
Engineering and applied sciences skills	53%	67%	55%	54%	66%	43%	50%
Mathematics, statistics, and data management skills	55%	75%	57%	54%	60%	60%	25%
Organisational and leadership skills	57%	67%	55%	77%	60%	55%	63%
Marketing skills	64%	67%	64%	62%	68%	64%	38%
Multimedia skills	64%	58%	64%	54%	70%	57%	50%
Financial skills for investment and access to finance	55%	50%	57%	31%	70%	40%	25%

☐ less than 50%   ☐ 50%-74%   ■ 75% and more

Source: Authors' calculations based on online survey.
Notes: Base: All respondents.
Q: Over the next five years, does your enterprise envisage the need for training to develop the following skills of employed persons?

3.1.5 Suggestions for the development of programmes at national level to support the transition to a low-carbon economy

The respondents to the online survey suggested a range of initiatives to be considered at national level which in their view could support innovation and Ireland's transition to a low-carbon economy. The most relevant suggested initiatives are grouped and summarised below:

• Information programmes to increase awareness of climate change challenges and the transition to a low-carbon economy;
• Training and webinars on how SMEs could reduce carbon emissions;
• Mandatory disclosure of steps taken by companies to transit to a low-carbon economy;
• Mandatory reporting of CO2 emissions on electricity bills or corporate annual reports;
• Access to finance – grants to SMEs to finance training needs;
• Promoting the adoption and sustainable use of all forms of renewable energy;
• Fostering the use of digital technology for management.

3.2 Stakeholders' views

A summary of key findings from the online survey were presented and discussed with two groups of selected key stakeholders[7]. The discussion focused on the following issues:

• Challenges from climate change and Ireland's transition to a low-carbon economy;

• Skill sets needed to support innovation and Ireland's transition to a low-carbon economy;

• Training programmes to develop the skill sets needed;

• Evidence gaps;

• Suggested initiatives and programmes to support Ireland's transition to a low-carbon economy.

The stakeholders' views validated to a large extent the key findings from the online survey relating to the skill sets and training programmes needed to support enterprises to adapt to and mitigate challenges from climate changes in the medium term.

Business awareness

• Stakeholders highlighted a high awareness of climate change challenges and Ireland's Climate Action Plan across enterprises;
• There is a need for more clarity and a "Road Map" to guide enterprises through the complexity of the various pieces of legislation and policy objectives and targets;
• Concepts such as the "circular economy" need to be contextualised to each business given the variety of business activities.

[7] The participants were selected by Skillnet Ireland in consultation with the ESRI research team. Two workshops took place on the 24th June 2021.

Specific knowledge and expertise needs

• Small businesses are particularly exposed as they lack the necessary knowledge and resources:
  - to design business models for a green/low-carbon economy;
  - to track and report energy use and greenhouse gas (GHG) emissions;
  - to analyse customer data and reduce GHG emissions;
  - to track carbon print along the supply chain.
• Given the limited resources of SMEs, bringing the green issues together could facilitate SMEs' access and management.

Access to finance to invest in new green equipment and technologies

• Purchase of new equipment and technology requires a significant amount of investment, while the return is uncertain;
• Businesses have no knowledge to get access to information on emerging green techniques;
• Lack of expertise to know if new techniques are suitable for them or not, and whether the new techniques are efficient or not;
• Maintaining new equipment and technologies requires further cost and expertise.

Trainings needs and tailored training programmes

• The transition to a low-carbon economy goes with uncertainly. Legislations and policies may evolve over time, requiring different skills at different stages. Therefore, providing and developing training programmes to businesses on a continuous basis is needed;
• There is no "one-size fits all" training programme. Each business needs a tailored plan/roadmap to progress and manage its transition. It would be useful to train in-house leaders/experts to lead companies' transition, or the regulators would provide external and tailored support/roadmap for each business;

• The training programmes would need to be tailored to companies by region/industry/size and at different stages in transition as some companies are new to the transition process and some companies are already knowledgeable.

Improving policy making

• Tailored policies to each sector/business would help businesses to better act and manage the transition to a low-carbon economy;
• It would be helpful to integrate the different targets together to form a coherent policy that is clear and easy to implement.

Fostering a culture of a green/circular economy

• Promoting green activities within a business via peer workers is beneficial. For some activities that can be seen immediately and obviously to peer workers, it is easier to promote, e.g., reuse of materials, reducing waste;
• A culture of circularity could encourage further engagement;
• A circular economy is not just reusing of waste, but it also requires redesigning production lines.

Fostering collaboration and co-ordination

• Enhancing collaboration and co-ordination of different initiatives is important;
• A range of government departments and agencies provide various programs for businesses. It would be useful to integrate these programmes together to ease accessibility and to reduce duplications;
• Validation of new technologies. It might be useful to initiate credible standards of new green equipment and technologies so to reduce uncertainty relating to the adoption of such technologies;
• It might be helpful to initiate green labels for companies that adopted green technologies so to create financial incentives for more companies to follow;
• Incentivize SMEs financially. Identify which piece of the transition to green economy is most financially attractive to SMEs.

4.

Conclusions and Recommendations

This research study examined current and emerging skill needs within Ireland's private enterprise sector to enable innovation and support the transition to a low-carbon economy. More specifically this research provides novel evidence on:

- Business awareness of and exposure to climate change challenges;

- Skill needs in the medium term to support enterprise innovation activities and the transition to a low-carbon economy;

- Existing training programmes and future training needs to develop the necessary skill sets.

The key findings emerging from this research are summarised on the following page.

1 Awareness of and Exposure to Climate Change Challenges

A large proportion of enterprises (nearly 80% of all enterprises) are aware of the European Green Deal, the EU plan to achieve climate neutrality by 2050. Looking across enterprise groups, the highest awareness is by enterprises in the construction sector, SMEs and enterprises in the industry sector. The lowest awareness appears to be in the large enterprises group. Almost 60% of enterprises which are aware of the European Green Deal, associate achieving carbon neutrality by 2050 with a positive impact in the medium term on enterprise performance while 31% of enterprises think the impact will be neutral. Only 10% of enterprises perceive achieving this goal as having a negative impact on their enterprises. Almost one third of respondents in the construction sector who are aware of the European Green Deal think it will impact negatively on their enterprises.

The majority of enterprises (91%) are aware of Ireland's Climate Action Plan. Across enterprise groups, awareness is the highest in the construction sector (all respondents), the SMEs group (92% of all respondents), and in the industry sector (90% of all respondents). Only 50% of respondents from large enterprises are aware of Ireland's Climate Action Plan.

Developing new skills within the enterprise workforce appears to be the top challenge from the implementation of Ireland's Climate Action Plan enterprises face in the medium term (73% of enterprises which are aware of Ireland's Climate Action Plan). The next most important challenges are improving the way in which resources are used in their supply chain to reduce emissions (69% of enterprises which are aware of Ireland's Climate Action Plan) and improving energy efficiency of processes, buildings and transport (for 65% of enterprises which are aware of Ireland's Climate Action Plan). Innovations in production, distribution, and marketing is a challenge for 55% of enterprises, while 48% of enterprises perceive replacing fossil fuel with renewables in production processes, building and transport as a challenge from the implementation of Ireland's Climate Action Plan.

A large proportion of enterprises anticipate that measures for the adjustment of production patterns required to address climate change will affect them in the medium term (63% of all enterprises). Other measures expected to impact a large proportion of enterprises include compliance with regulations (59% of all enterprises); implementation of new technologies (55% of all enterprises), reducing carbon emissions (55% of all enterprises), and adjustment of consumption patterns (55% of all enterprises). Looking at responses by enterprise groups, SMEs appear to be most exposed to measures relating to adjustment of production patterns (73% of respondents) while large enterprises identify implementation of new technologies as the main set of measures to address climate change that will affect their activity in the medium term (75% of respondents). For Irish-owned enterprises, the measures that will affect their activity most appear to be expanding recycling efforts (72% of respondents). Adjustment of production patterns is perceived as the top exposure for foreign-owned enterprises (85% of respondents). Enterprises in industry are most exposed to expanding recycling efforts (80% of respondents) while enterprises in the services sector are most exposed to implementation of new technologies (67% of respondents). Measures for the adjustment of production patterns appear to affect most of enterprises in the construction sector (88% of respondents).

2 The Impact of the Transition to a Low-Carbon Economy on Skill Needs

Three quarters of enterprises anticipate that the impact of the transition to a low-carbon economy will come through a shift of activities from less to more energy efficient and less polluting activities. For both SMEs and large enterprises the impact of the transition to a low-carbon economy on skills needs is expected to come mainly through a shift of activities from less to more energy efficient and less polluting activities. Emerging new occupations following on from new regulations and the development of new technologies has been identified by large enterprises as an equally important channel for the impact of the transition to a low-carbon economy on skill needs.

3 Skill Needs in the Medium Term to Support Enterprise Innovation Activities and the Transition to a Low-Carbon Economy

The top skill sets needed in the medium term to support enterprise innovations with environmental benefits include climate change and sustainability strategy skills (84% of all enterprises); marketing skills (70% of all enterprises); and financial skills relating to investment and access to finance (67% of all enterprises). Looking across enterprise groups, climate change and sustainability strategy skills to support green innovation were identified as needed in the medium term by over three quarters of respondents in all groups with the exception of large enterprises. Three quarters of respondents in large enterprises identified a broader range of skills to support green innovation which are needed in the medium term: sector-specific technical skills; web design; mathematics, statistics and data management; organisational and leadership skills. Financial skills relating to investment and access to finance together with climate change and sustainability strategy skills are the most needed green innovation skills for foreign-owned respondents. Financial skills relating to investment and access to finance were identified as the most needed green innovation skills for respondents in the construction sector.

The following patterns emerge for innovation skills that support green innovations:

- **Skills with high-demand and low supply/high recruitment difficulty:** Climate change and sustainability strategy skills;
- **Skills with high-demand and high supply/low recruitment difficulty:** Sector-specific technical skills; Software development; Web design; Marketing skills;
- **Skills with low demand and high-supply/low recruitment difficulty:** Engineering and applied science skills; Mathematics, statistics and data management skills; Organisational and leadership skills; Multimedia skills; Financial skills relating to investment and access to finance;
- **Skills with low-demand and low-supply/ high recruitment difficulty:** C: Design skills.

Looking at responses across enterprises groups, at least 50% of respondents from enterprises which are SMEs, large, Irish-owned and in the industry sector reported plans to recruit in the medium term the full range of green innovation skills. Climate change and sustainability strategy skills were identified as being most demanded by respondents from SMEs, Irish-owned enterprises and from enterprises in the industry and construction sectors. Sector-specific technical skills are most demanded in large enterprises and in the services sector. Climate change and sustainability strategy skills is the innovation skills set most difficult to recruit as identified by at least 50% of respondents in all enterprise groups with the exception of respondents from large enterprises. Sector-specific technical skills are most difficult to recruit by large enterprises (75% of respondents).

The top skill sets needed in the medium term to support the transition to a low-carbon economy identified by enterprises include: waste management skills (78% of all enterprises); corporate sustainability strategy skills (75% of all enterprises); carbon management skills (67% of all enterprises); and sustainable finance skills (67% of all enterprises). The full range of green skills analysed were identified as needed in the medium term by over half of respondents across all enterprise groups. Corporate sustainability strategy skills tops the range of green skills needed for all enterprise groups with the exception of large enterprises and enterprises in the industry and services sectors. Carbon management skills are the most needed green skills for large enterprises while waste management skills tops the green skill needed for enterprises in the services sector.

The following patterns emerge for green skills that support the transition to a low-carbon economy:

• **Skills with high demand and low supply/ high recruitment difficulty:** Corporate sustainability strategy skills; Energy-efficiency design skills; Green procurement skills;

• **Skills with high demand and high supply/ low recruitment difficulty:** Carbon management skills; Water management skills;

• **Skills with low demand and high-supply/ low recruitment difficulty:** Waste management skills; Building and retrofits skills; Sustainable transport and logistics skills; Sustainable finance skills.

Looking at responses across enterprise groups, over half of respondents from SMEs and Irish-owned firms as well as respondents from enterprises in the industry sector plan to recruit in the medium term the full range of green skills analysed. Over three quarters of respondents in the industry and construction sectors plan to recruit employees with corporate sustainability strategy skills, energy-efficiency design skills, and green procurement skills. Corporate sustainability strategy skills is the top green skills set for recruitment plans of respondents from SMEs, and from the services and construction sector. Respondents from large enterprises identify sustainable finance skills as the top green skills set for recruitment in the medium term. Enterprises in the industry and construction sectors appear to be most exposed to difficulties in the medium term in relation to recruiting employees with green skills. Over 50% of respondents from the industry sector identify recruitment difficulties for all green skills with the exception of energy-efficiency design skills (48% of respondents) and building and retrofits skills (46% of respondents). All respondents in the construction sector report recruitment difficulties for employees with energy-efficiency design skills and 75% of respondents for employees with corporate sustainability strategy skills. 50% or more of respondents in the construction sector report recruitment difficulties for all the other green skills sets with the exception of water management skills (38% of respondents).

4 Training Needs in the Medium Term to Support Green Innovations and the Transition to a Low-Carbon Economy

Examining training needs for green innovation skills in the medium term, multimedia skills has been identified as the most demanded (51% of all enterprises). The next most demanded training programmes are on organisational and leadership skills (50% of all enterprises) and marketing skills (48% of all enterprises). A broad range of training needs related to green innovation skills are identified across enterprise groups. Across all enterprise groups, those identified by at least 50% of respondents include training on software development; organisational and leadership skills; multimedia skills; web design (all groups with the exception of enterprises in the services sector); engineering and applied sciences skills (all groups with the exception of enterprises in the services sector); mathematics, statistics, and data management skills (all groups with the exception of enterprises in the construction sector); marketing skills (all with the exception of enterprises in the construction sector). At least 50% of respondents from large enterprises, SMEs, Irish-owned enterprises and enterprises in the industry sector identify training needs in all green innovation skills analysed with the exception of design skills (47% of respondents from SMEs; 49% of respondents from Irish-owned enterprises; 46% of respondents from the industry sector).

Among the analysed green skills to support Ireland's transition to a low-carbon economy, training in corporate sustainability strategy skills is the most needed in the medium term (59% of all enterprises). The next most needed training programmes are for sustainability finance skills and energy-efficiency design skills (47% of all enterprises). The need for training in corporate sustainability strategy skills has been identified by over 50% of respondents from all enterprise groups (78% of respondents from the industry sector; 75% of respondents from the construction sector; 69% of respondents from SMEs and Irish-owned enterprises).

The above key findings were validated to a large extent by the views of stakeholders collected during two workshops. The discussion also highlighted a range of issues related to skill sets and training programmes needed to support enterprises to adapt to and mitigate challenges from climate changes in the medium term.

Taken together, the results of this research suggest a number of recommendations for designing training programmes to support enterprise innovation and the transition to a low-carbon economy:

Developing and providing training programmes to businesses on a continuous basis is needed given the uncertainty and dynamics of climate change challenges and related policy and legislation. Training programmes should aim at enabling and fostering a culture of circularity/green economy.

Training programmes focused on developing skills and talent to support the transition to a low-carbon economy should prioritise developing skill sets which are in high demand and low supply including: climate change and corporate sustainability strategy skills; energy-efficiency design skills; green procurement skills.

Enhancing collaboration and co-ordination of different initiatives is important. A range of government departments and agencies provide various training programmes for businesses. It would be useful to integrate these programmes together to ease accessibility and to reduce duplications.

Training programmes are needed to guide enterprises through the complexity of the various pieces of legislation and policy objectives and targets. In particular, there is a need for more clarity and a "Road Map" to achieving a low-carbon economy. Furthermore, concepts such as the "circular economy" need to be contextualised to each business given the variety of business activities.

Tailored training programmes to each sector/ enterprise group and at different stages in the transition to a low-carbon economy would help businesses to better act and manage the transition to a low-carbon economy. Programmes to train in-house leaders/experts to lead companies' transition would provide external and tailored support/roadmap for each business.

Further Research

Given the growing importance of digital technologies for innovation and a more sustainable long-term growth, access to digital skills will be crucially important. We suggest that further research could examine in more depth:

(i) the extent to which digital technologies are used in the enterprise sector in Ireland;
(ii) existing gaps between the required and available digital skills across sectors and enterprise groups;
(iii) existing barriers to the availability of digital skills;
(iv) actions undertaken by employers to address existing digital skill gaps; and
(v) lessons that could be learned from other advanced economies in terms of training programmes and other initiatives to address the digital skills gaps.

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Appendix A

Online Survey: Profile of Respondent Firms

Table A1 Profile of respondent firms by sector

Sectors	Number of firms
Industry (Manufacturing & Utilities)	50
Construction	8
Services	42
All Sectors	100

Source: Online survey conducted by Integral Research.

Table A2 Profile of respondent firms by region

Region	Number of firms
Border	4
Dublin	43
Mid-East	13
Midlands	9
Mid-West	6
South-East	10
South-West	5
West	10
All regions	100

Source: Online survey conducted by Integral Research.

Table A3 Profile of respondent firms by size

Size Group	No. of Employees	Number of firms
Micro	0-9	24
Small	10-49	36
Medium sized	50-249	28
Large	250 & more	12
All Firms		100

Source: Online survey conducted by Integral Research.

Appendix B

Online Survey: Quality Checks

The following items have been monitored during the project to ensure representativeness quotas are reached with good quality responses:

- Length of interview

- Flat-lining or patterning of grid questions

- Excess "Don't know" or "Not Applicable" responses

- Inter-question logic checks

- Verbatim/open numeric junk

- Quality control question failures

- IP address (Elimination of duplicates)

About and Acknowledgements

Prof Dr Iulia Siedschlag leads the ESRI's research on *Competitiveness, Trade and Foreign Direct Investment.* Her research focuses on international trade, foreign direct investment, innovation, productivity and economic growth in advanced and emerging economies. She has successfully led a significant number of international research consortia involving research institutes and universities from Europe. Iulia has advised such organisations as the European Commission, the European Central Bank, the World Bank, the Inter-American Development Bank, the Asian Development Bank Institute, the International Labour Organisation, and the World Economic Forum.

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Skillnet Ireland is a national business support agency of the Government of Ireland responsible for the promotion and facilitation of talent development within enterprise. Skillnet Ireland is funded from the National Training Fund through the Department of Further and Higher Education, Research, Innovation and Science. We help businesses in Ireland to be the best they can be, through innovative and enterprise-driven talent development.

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About Climate Ready

Skillnet Ireland launched Climate Ready in 2021 to develop Ireland's talent for the transition to a low-carbon economy. Climate Ready equips businesses with the practical skills and knowledge they need across a range of critical areas to prepare for this change - delivering real results for our economy, workforce and climate. Climate Ready supports businesses to build a culture of sustainability through specialised talent development and upskilling supports.

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Notes

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**An Roinn Breisoideachais agus Ardoideachais,
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