From green ambition to financial prosperity: investigating the dynamics of cleantech firms in Europe - a survey analysis

Politecnico di Torino and Universitat Politècnica de Catalunya

Sara Giusi

April 2024

Abstract

The European cleantech sector has flourished in the past decade, positioning itself as a leader in innovation. However, challenges persist in scaling and industrializing these technologies. Europe's ambition to claim a significant share of the 650 billion euro clean technology market by 2030 necessitates addressing gaps in growth equity and scale-up finance for sustained competitiveness.

The European Green Deal (EGD) establishes legally binding objectives for both the EU and its member states, requiring new regulations and revisions to facilitate an eco-friendly transition. On February 1, 2023, the Commission presented the Green Deal Industrial Plan in Brussels, aiming to bolster the EU's manufacturing capacity for net-zero technologies. Ursula von der Leyen, President of the European Commission, envisions Europe leading in clean technology development, promoting quality jobs, innovation, and mass production.

European entrepreneurs emphasize the importance of streamlining regulations, ensuring fair competition, and addressing funding gaps. To quantitatively assess these challenges, this thesis conducts a survey involving 332 companies from 25 European countries. Respondents are companies in the cleantech sector, with 73 percent having cleantech as part of their company mission and vision, 59 percent being driven by new business opportunities, and 27 percent having to comply with regulations. Challenges faced when operating in this field include strict regulations (47 percent), technological complexities (36 percent), and limited external funding (36 percent). Environmental, product safety, and operational safety policies have a significant impact on companies, emphasizing the need for a simplified regulatory environment. Access to finance proves challenging for companies, citing complex application processes and high competition. Current financing methods include internal funds and bank debt, with considerations for future options such as green bonds/ESG and hybrid financing. A shortage of skills, particularly in legal and intellectual property management, is evident. Supply chain preferences favor European suppliers for quality (70 percent) and price (60 percent), with limited use of local suppliers

Despite companies' confidence in Europe's financial commitment to achieving net zero, doubts remain about the ambitious nature of these targets. As a result, while companies are optimistic about their ability to cut CO_2 emissions, there are fewer assurances that national and EU targets will be met.

The thesis aims to bridge qualitative insights with quantitative data, providing a comprehensive understanding of the challenges and opportunities within the European cleantech sector. The findings are intended to guide policymakers and serve as the foundation for subsequent research within the CLEU project. It is important to acknowledge limitations, including sample biases and temporal constraints inherent in the dynamic nature of the cleantech sector.

Dedication

Al Signor Jack, senza cui questa tesi non sarebbe mai esistita.

Contents

List of Figures

Glossary

CEO Chief Executive Officer. 10, 11

CLEU Research Project "The cleantech industry in the EGD: policy challenges and the finance landscape for SMEs". 13, 23, 25, 69

DIG Department of Management, Economics, and Industrial Engineering at Politecnico di Milano. 13

DIGEP Department of Production and Management Engineering at Politecnico di Torino. 13

DISA Department of Management at Alma Mater Studiorum Università di Bologna. 13

EEA European Environment Agency. 9

EGD European Green Deal. 6, 11–15, 19, 24, 25, 59, 60

EIB European Investment Bank. 13, 24, 69

EIBURS European Investment Bank's University Research Sponsorship. 13, 21, 54, 69

EIF European Investment Fund. 13, 24, 54, 69

EPO European Patent Office. 54

ERC European Research Council. 16

GHG Greenhouse Gas. 5, 10, 22

IRA Inflation Reduction Act. 15

LULUCF Land Use, Land Use Change, and Forestry. 10

ML Machine Learning. 26

MtCO_2**e** Megatonnes of Carbon Dioxide Equivalent. 10

OECD Organisation for Economic Co-operation and Development. 15, 17, 21

R&D Research and Development. 15, 17, 43

RRF Recovery and Resilience Facility. 16

SCRES Supply Chain Resilience. 19

SDGs Sustainable Development Goals. 70

SMEs Small and Medium-sized Enterprises. 13, 15–18, 20, 51, 54, 70

SPSS Statistical Package for the Social Sciences. 26

STEP Strategic Technologies for Europe Platform. 16

TRL Technology Readiness Level. 5, 42, 43

VC Venture Capital. 54

Chapter 1

Introduction

1.1 Background and context

Climate change is a pressing and multifaceted environmental challenge that has been steadily transforming the world's landscapes and ecosystems. Over recent decades, the Earth has experienced noticeable shifts in weather patterns, rising temperatures, increased frequency of extreme weather events, and altered precipitation trends, all attributed to the changing climate. These changes have significant implications for both natural environments and human societies, affecting agriculture, water resources, energy systems, and public health [3]. In addition, failing to take action against these changes could compel individuals to abandon their homes and migrate, potentially leading to conflicts and security risks.

The European Union, together with its Member States, has implemented a comprehensive system of policies and measures to fulfill its climate change mitigation commitments under the United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement. The European Green Deal (EGD), introduced in December 2019, acts as a catalyst for more ambitious targets: **EU leaders envision making Europe the world's first climate-neutral economy by 2050** [4]. The fight against climate change is expected to foster sustainable economic growth, generate employment opportunities, provide health and environmental benefits to citizens, and contribute to the EU's long-term competitiveness.

To achieve carbon neutrality by 2050, **the European Union have endorsed a net domestic emissions reduction target for 2030 of at least 55 percent compared to 1990 levels**, as shown in Figure 1.1 released by EEA in 2022 [1].

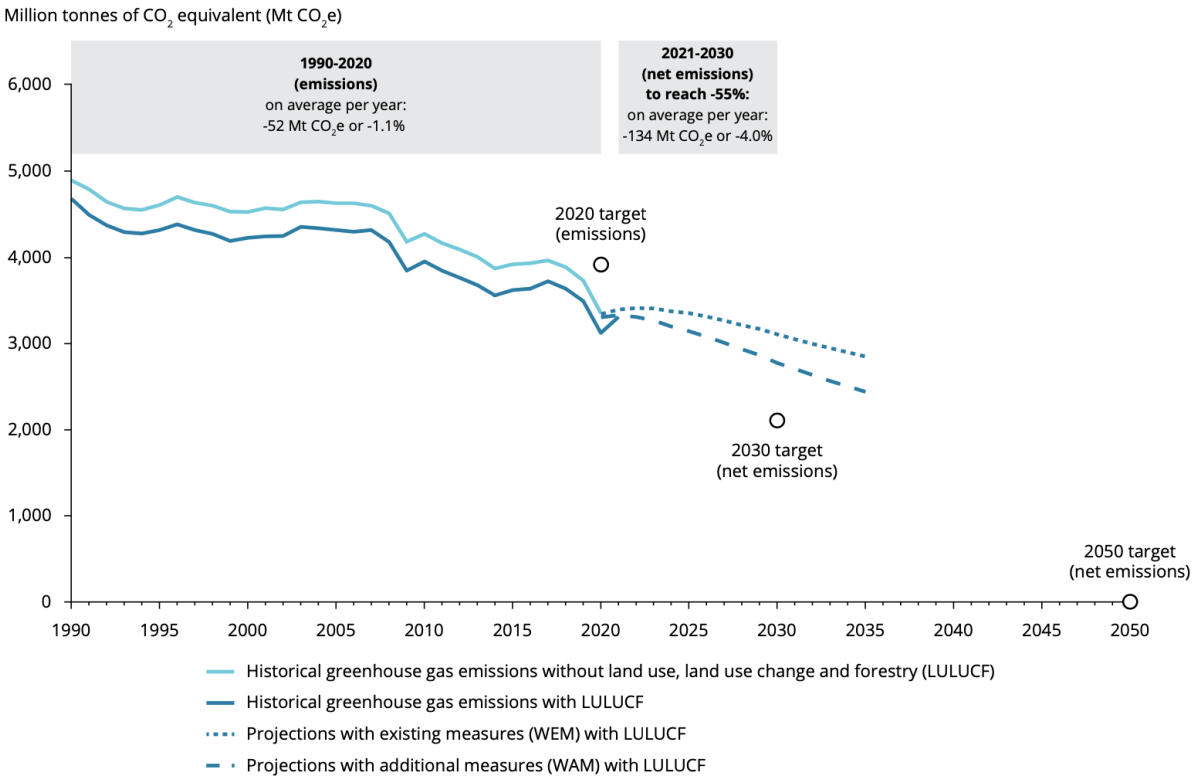

Figure 1.1: Historical trends and future projections for greenhouse gas (GHG) emissions [1]

The historical development of GHG emissions is shown both excluding the sector of land use, land use change and forestry (LULUCF) (light blue solid line) and including LULUCF (blue solid line). Projections are shown in dashed and dotted blue lines and relate to the 2030 target's scope, starting from 2020. The top-left grey bar indicates the average annual change in emissions (including international aviation, but excluding LULUCF emissions and removals) that occurred between 1990 and 2020. The top-right grey bar indicates the change that will be necessary between 2021 and 2030 on an average annual basis to achieve a net reduction in emissions of 55 percent compared with 1990 levels, assuming the maximum contribution of net removals from the LULUCF sector to the Union target of 225 megatonnes of carbon dioxide equivalent (MtCO_2e) in 2030. **At present, the available data suggests that the European Union is facing challenges in achieving its goal by the year 2030**.

1.2 Problem statement

Over the last 10 years, thanks to significant investments, Europe has become a powerhouse of cleantech innovation, but **while Europe is great at inventing and developing clean technologies, it still struggles to scale and industrialize them**. With competition heating up from the US and beyond, success in this scale-up effort is crucial to European future competitiveness.

The Cleantech for Europe [5] annual summit serves as a platform for cleantech CEOs and policy leaders, facilitating the exchange of perspectives and ideas, with the ultimate goal of bridging the gap that currently exists between the cleantech innovation realms and policy communities [6].

During the last edition in 2023, Margrethe Vestager, the Executive Vice President of the European Commission, expressed hope that the European Union is well-positioned to capture a significant portion of

the mass-manufactured clean technology market (that would be worth 650 billion euros by 2030) as the EGD creates the right regulatory signals to enable the private sector to plan investments and leverage the first-mover advantage in the green economy.

Jules Besnainou, the Executive Director at Cleantech for Europe, emphasized that the EU should ensure the protection of fair competition across the EU and between large and small companies that are scaling up. In Europe, seed funding doubled in the previous year, indicating that the very early stages of innovation are flourishing. There is a robust supply of financiers to support cleantech companies from their early stages to early commercialization. However, what is still missing is growth equity and scale-up finance. Bridging this gap is crucial, as it is at this stage that competition intensifies with the US. Many companies consider relocating to the US when they reach the scale-up phase because they cannot find capital in the EU anymore.

1.2.1 Insights from entrepreneurs

The insights offered by entrepreneurs during the Cleantech for Europe annual summit 2023 collectively support the need for streamlining regulations and facilitating easier access to capital.

Henrik Henderson, the CEO of H_2 Green Steel [7], underscores the urgency of **streamlining the regulatory framework**. He also raises concerns about the unequal distribution of funds, which often favor established companies over smaller, innovative ones. Henderson calls for **fair treatment within the Single Market**, emphasizing that every European company should be treated equally, regardless of its country of origin.

Vaitea Cowan, Co-founder of Enapter [8], offers insights into the complexities of regulatory processes and the delayed progress of renewable hydrogen projects and electrolyzer production. Cowan proposes that **EU funds be made more accessible through standardized requirements and application procedures**. Additionally, she calls upon the EU to leverage its technological leadership to establish global standards for renewable hydrogen.

Carlos Monreal, the President and CEO at Plastic Energy [9], draws attention to the need for **easier access to capital**, particularly for scaling up clean technology ventures. Monreal also underscores the rapid policy development in the USA, leading to streamlined permitting processes within months, a process that can take several years in Europe.

1.2.2 Insights from members of the Cleantech Friendship Group

Subsequently, also members of the Cleantech Friendship Group [10] collectively emphasize the importance of simplified regulations, workforce development, and the mobilization of funding. Although their observations refer to specific technologies, they report cross-cutting problems in the cleantech sector.

Martin Hojsik highlights the underrepresentation of geothermal energy in EU policies and urges the establishment of a European geothermal alliance to stimulate the industry. He emphasizes the importance of **retaining the industrial base in Europe during the scale-up phase**, along with the need for **clear instruments for blended finance** and **harmonized rules for a Single Market**.

Nicolas Gonzalez Casares calls for **policymakers to provide a precise definition** of long-duration energy storage. He emphasizes the need to **engage various sources of financing**, including banks, public organizations, and private investors, to support mature energy storage technologies. Additionally, he

mentions the importance of **reskilling workers from other industries to address skill shortages** in long-duration energy storage.

Lidia Pereira underscores the **need for a clear definition** of "green hydrogen" within policies and investments. She identifies **skills as a bottleneck**, advocating for the development of both skilled labor and business expertise to facilitate the scaling of emerging hydrogen technologies. She also highlights the importance of **sourcing critical materials at competitive costs** and suggests **prioritizing short supply chains** for energy security, sustainability, and competitiveness.

Peter Vitanov envisions batteries and electric trucks as central to the future of the European economy. He notes that new legislation regarding CO_2 standards for heavy-duty vehicles is expected to significantly impact the industry. He expresses concerns about the **complexity of European legislation compared to more straightforward regulatory structures in other regions, such as the USA**. **Predictability in demand and profit margins** is needed to provide a stable foundation for business development and scaling up within the transport sector.

1.3 Research objectives

The critiques and suggestions gathered during the various conferences are very valuable, as they revealed the experiences of those actively involved in the cleantech sector. However, before mobilizing funding and implementing new policies, it is crucial to acquire more quantitative knowledge. This will enable European institutions to estimate the effects of implementing specific policies and regulations, as well as the impact of different funding sources on the financial and innovation performance of cleantech companies.

To bridge this information gap, **this thesis aims to find out what companies think about the design and feasibility of the EGD goals. It also explores how European cleantech companies contribute to a clean and circular economy, with the ultimate goal of proposing initiatives to policymakers to improve the regulatory and financial environment in which they operate**.

To accomplish this, the thesis will utilize data obtained through a survey. The survey will evaluate the impact of policies and regulations, explore potential adverse effects, and gather suggestions for enhancing their effectiveness. It will also scrutinize companies' willingness to secure funding, especially for cleantech initiatives. Additionally, it will analyze the challenges that companies encounter when accessing public financing programs and their inclination to employ alternative financing methods. The survey will investigate the types of skills (technical, managerial, and soft skills) that companies require, examining whether these skills will be outsourced, provided internally, or are readily available. Lastly, the survey will collect data on companies' supply chain structures and resilience strategies, while seeking suggestions for potential government interventions.

1.4 Limitations

The analysis of survey results requires consideration of several limitations. Firstly, surveys are based on a sample drawn from a larger population. The representativeness of the sample may suffer from biases such as self-selection or non-response bias, affecting the generalizability of the results to the larger population. Also, low response rates reduce the validity of the findings, impacting the robustness of the

conclusions.

The possibility of accurate analyses also depends on the design of the survey. Poorly constructed questions, ambiguous wording or limited response options can compromise the quality of the collected data. Indeed, the depth of responses may be limited as respondents may not have the opportunity to express nuanced or complex opinions due to the structured nature of the survey. Furthermore, respondents might provide socially acceptable or desirable answers rather than reflecting their true opinions or behaviour, potentially leading to biased results.

Additionally, it is essential to recognise that surveys provide a snapshot at a specific point in time, but the cleantech sector is remarkably dynamic, which limits the temporal scope of the investigation.

1.5 Rationale

The survey discussed in this thesis is the outcome of the author's collaboration with the Politecnico di Torino from February to October 2023, contributing to the Research Project "The cleantech industry in the EGD: policy challenges and the finance landscape for SMEs (CLEU)", funded by the European Investment Bank (EIB)'s University Research Sponsorship (EIBURS) programme and coordinated by the Research and Market Analysis Division of the European Investment Fund (EIF). The project is conducted by the Department of Production and Management Engineering (DIGEP) at Politecnico di Torino[11], in collaboration with the Department of Management, Economics, and Industrial Engineering (DIG) at Politecnico di Milano [12], and the Department of Management (DISA) at Alma Mater Studiorum Università di Bologna [13]. The Scientific Coordinator of the project is Prof. Elisa Ughetto, and the scientific coordinators for the partner universities are Prof. Annalisa Croce and Prof. Laura Toschi, respectively.

Chapter 2

Literature review

The literature review begins with an overview of the EGD and its four pillars: establishing a predictable and simplified regulatory environment, speeding up access to finance, enhancing skills, and promoting open trade for resilient supply chains.
Subsequently, an analysis of the cleantech sector will be undertaken. The primary objective is to understand what falls within the realm of cleantech, considering that the meaning of this still relatively young term is a subject of debate and lacks a globally accepted definition.

2.1 The European Green Deal

By the European climate law, the EGD objectives are legally binding for both the EU and its member states, necessitating the need for new regulations and revisions of EU legislation to facilitate the transition to a more environmentally friendly approach.

The 1^{st} February 2023, in Brussels, the Commission presents a **Green Deal Industrial Plan** to provide a more supportive environment for the scaling up of the EU's manufacturing capacity for the net-zero technologies and products required to meet Europe's ambitious climate targets. On that occasion, Ursula von der Leyen, President of the European Commission, expresses hope and enthusiasm for the opportunity for Europe to take a leading role in the development and deployment of clean technologies, stating that: "*We have a once in a generation opportunity to show the way with speed, ambition and a sense of purpose to secure the EU's industrial lead in the fast-growing net-zero technology sector. Europe is determined to lead the clean tech revolution. For our companies and people, it means turning skills into quality jobs and innovation into mass production, thanks to a simpler and faster framework. Better access to finance will allow our key clean tech industries to scale up quickly*" [14].

The Green Deal Industrial Plan is based on four pillars: a predictable and simplified regulatory environment, speeding up access to finance, enhancing skills, and open trade for resilient supply chains. The following sections will detail the main initiatives proposed for each pillar and the context in which they are embedded.

2.1.1 A predictable and simplified regulatory environment

The first pillar of the Green Deal Industrial Plan revolves around simplifying the regulatory landscape, aiming to establish a more efficient and predictable framework. To achieve this objective, three main initiatives have been put forth: the **Net-Zero Industry Act**, designed to accelerate the adoption and scaling up of cutting-edge technologies throughout the Single Market; the **Critical Raw Materials Act** to

address the critical issue of ensuring reliable access to essential materials, including rare earth elements; the **Reform of Electricity Market Design** aiming to accelerate a surge in renewables and the phase-out of gas, make consumer bills less dependent on volatile fossil fuel prices and better protect consumers from future price spikes and potential market manipulation [15].

The OECD [16] defines *regulation* as "a set of incentives established either by the legislature, Government, or public administration that mandates or prohibits actions of citizens and enterprises [...]. Regulations are supported by the explicit threat of punishment for non-compliance" [17]. The content of regulations could be an important source for innovation but also a severe obstacle for innovation activities [18].

For example, antitrust regulation has a positive impact on R&D intensity [19]. This finding aligns with the positive correlation found between competition intensity and innovation activities [20]. On the other hand, it has been identified a negative correlation between the intensity of product market regulation and the intensity of R&D spending in OECD countries [21].

The primary barriers impeding investments in climate-related projects are uncertainties regarding regulations and taxation: as the level of uncertainty increases, marked by variations in expected returns on innovation, companies are inclined to postpone or scale back their innovation endeavors [22]. Conversely, regulatory frameworks that offer flexibility through incentives and performance standards prove more conducive to foster innovation, enabling companies to implement cost-effective and commercially viable solutions [23].

Excessive regulation is an emerging barrier to the survival and growth of SMEs [24]. **Small businesses are more severely affected by red tape than are large companies because are less proficient in dealing with the complexities of regulation and are unable to spread the costs of compliance across large-scale operations**.

These findings are concerning in light of data indicating that environmental regulations have a positive impact on innovation [25, 26, 27, 28, 29, 30, 31, 32]. The reinforcement of environmental regulations starting from the early 1990s has made an economically meaningful contribution to the rise in environmentally friendly innovation. These impacts typically became evident within a span of 2 to 3 years following the implementation of the policy adjustments. This phenomenon was attributed to the individually significant effects of both market-oriented policies (such as feed-in tariffs and trading schemes), as well as non-market policies (including research and development subsidies or emission limits) [33].

2.1.2 Speeding up access to finance

In the EU, a third of the world's best-ranked research institutions are located, along with a third of the world's patents and more startups in the climate space than the US and China combined. However, while Europe has leadership in early-stage R&D, the US surpasses Europe in funding availability, especially now, thanks to the Inflation Reduction Act (IRA), a policy framework that provides clear incentives for investors and companies, boosting investment decisions.

Europe has become increasingly aware of the need to support cleantech in response to the US IRA. To address this challenge, the second pillar of the EGD will focus on expediting financing for clean technologies in Europe. Recognizing that public financing plays a pivotal role in unlocking the substantial private investments required for the green transition, policymakers at the EU level have designed a wide range of funding mechanisms [2]. Specifically, the European Commission estimates an investment need

of €92 billion in total for the period between now and 2030, with public funding requirements of between €16-18 billion [34]. The Figure 2.1 gives an overview of the EU public finance landscape for cleantech.

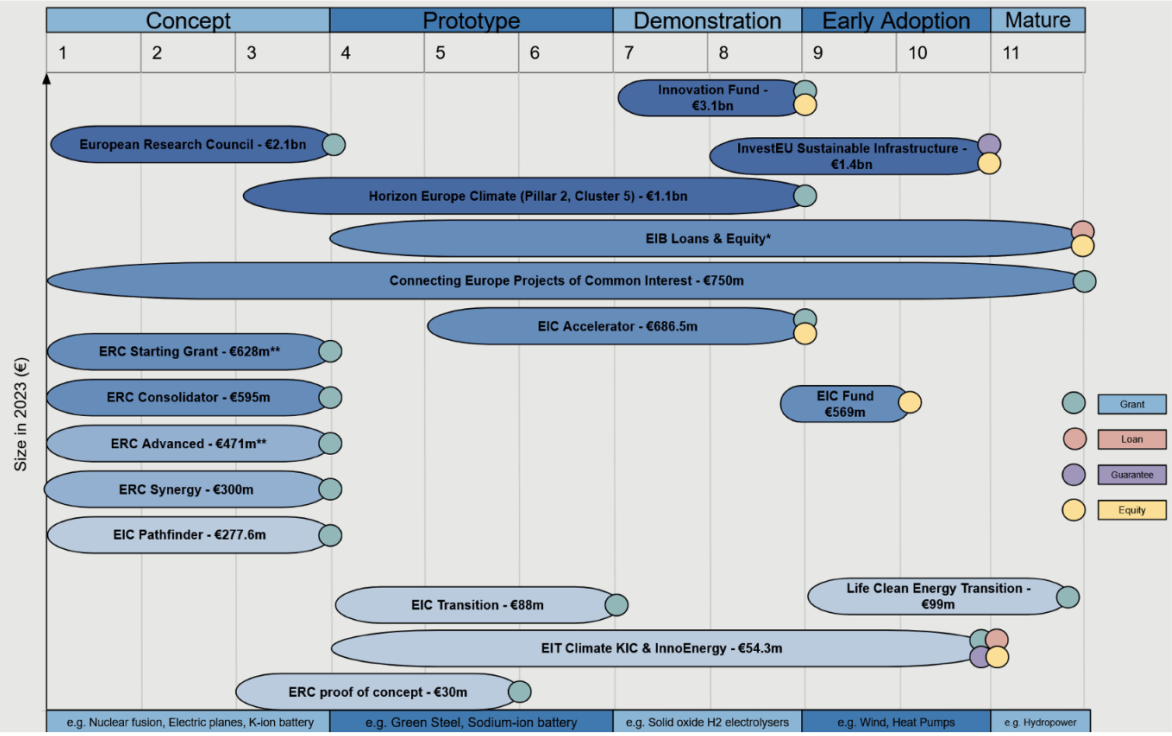

Figure 2.1: EU public finance landscape for cleantech [2]

Within the funds depicted in the figure, the principal features of those of greater economic significance will be provided. The **Innovation Fund** disburses grants through regular calls for projects, typically supporting first-of-a-kind demonstration projects to prove a technology's commercial readiness before scaling up operations and entering the market. The **European Research Council (ERC)** supports cleantech, deeptech, and biotech start-ups. **InvestEU** brings together a wide range of pre-existing EU and Member State financial instruments to provide support to businesses, SMEs, researchers, and infrastructure projects. **Horizon** is the world's largest multinational research and innovation initiative, encompassing a wide range of thematic areas, including health, climate, digital technologies, and social challenges. Finally, the **Strategic Technologies for Europe Platform (STEP)**, announced by the European Commission in June 2023, leverages existing financial instruments such as the Recovery and Resilience Facility (RRF), InvestEU, Horizon Europe, and the Innovation Fund. Investments will not only be channeled into cleantech but also deeptech and biotech. STEP introduces a "Sovereignty Seal", a label designed to facilitate access to private and public funds for highly rated, strategic projects.

Clearly, the EU has a wide range of financial instruments to support cleantech, and it is particularly well equipped when it comes to supporting early-stage researchers and innovators. What the EU lacks, by contrast, is the financial arsenal necessary to support cleantech manufacturing at scale, which will be central to European climate action in the near future [2].

Focusing on innovative SMEs, the type of financing required by them is long-term, capital-intensive, and exposed to three main risks simultaneously: technological risk, market risk, and regulatory risk. It is often viewed as an investment suitable only for FFF—family, friends, and fools. However, improved

access to finance is essential for SMEs to enhance productivity and introduce innovation-oriented practices. These, in turn, are crucial for enhancing competitiveness, entering new foreign and domestic markets, and achieving overall growth [35].

Globally, **bank finance** remains the most important source of external financing for SMEs. However, conventional debt financing is particularly ill-suited for high-growth and innovative early-stage firms, which, in addition to lacking a credit history and collateral, operate in a rapidly changing environment. Instead, **venture capital** financing is considered the primary source of external funding for Cleantech companies because Cleantech innovations require substantial upfront investments from the early stages of R&D. Moreover, it is not only about money; in addition to providing financial support, venture capitalists offer triple bottom-line business advice and network support [36].

Alternative instruments include **microfinance**, which is a common tool to increase financial intermediation among smaller enterprises that are typically not yet covered by commercial banks. Other non-bank financial instruments include asset-based financing tools such as leasing and factoring, which can provide credit to enterprises without sufficient collateral or credit history. **Leasing** can help SMEs modernize equipment and implement expansion plans in the absence of bank loans or financial resources of their own. **Factoring** is an instrument based on the sale of accounts receivable from a firm with a good credit performance; the firm can increase its cash flow by selling its invoices to a third party (a factor or factoring company) at a discount.

2.1.3 Enhancing skills

The impact of automation, digitalization, and the green transition on the labor market presents both challenges and opportunities. The OECD has observed a trend of increasing labor market polarization across its member countries, characterized by a decline in demand for middle-skilled workers and a simultaneous increase in demand for both high- and low-skilled workers [37].

Due to evolving skill requirements certain demographic groups are particularly vulnerable to job losses and long-term unemployment. These groups include migrants, youth, parents with young children, the elderly, long-term unemployed individuals, and those with disabilities, often comprising a higher proportion of workers with weaker labor market attachments. The COVID-19 crisis has further exacerbated existing inequalities in labor markets, disproportionately affecting these vulnerable groups. Despite the evident need for training, groups with weaker labor market connections remain less likely to participate in adult learning programs.

Additional European data supports these findings: in the European Union, more than three-quarters of companies report difficulty in finding workers with the necessary skills, but paradoxically only 37 percent of adults engage in regular training. Local governments are thus confronted with the significant challenge of reducing barriers to participation for groups in greatest need of re- and upskilling [38].

The third pillar of the Green Deal Business Plan positions itself as a multifaceted strategy to prepare the workforce for success in an ever-evolving green technology-driven economy. Firstly, the Commission is set to propose the establishment of **Net-Zero Industry Academies** dedicated to strategically rolling out up-skilling and re-skilling programs tailored to the specific needs of key industries. Furthermore, the Commission is committed to endorsing a **skills-first approach**. This entails prioritizing the recognition of practical skills, transcending the conventional emphasis on qualifications. In addition, the Commission aims to explore pathways for **facilitating the entry of third-country nationals into EU labor markets**, with a particular focus on priority sectors. Recognizing the critical importance of skills de-

velopment, the Commission seeks to **foster and align both public and private funding to support skill-building initiatives**, as it acknowledges that financial barriers often impede adults from participating in adult learning activities.

A substantial obstacle to put in place initiatives is the sparse literature on the skills gaps crucial to fostering green innovation [39, 40, 41, 42, 43].The United Nations Industrial Development Organization (UNIDO) has delineated four skill clusters deemed highly relevant for a sustainable green future: engineering and technical skills; scientific skills; operational management skills; and monitoring skills. Furthermore, there exist crucial soft skills such as empathy, creativity, adaptability, resilience, and design thinking [44]. Correspondingly, the World Economic Forum categorizes six key areas to promote green practices in organizations: science skills; architectural and planning skills; green engineering and tech skills; agricultural skills; environmental justice skills; systems skills [45]. Both classifications encompass a broad range of competencies, and formulating a comprehensive catalog of relevant skills that accurately represents the diverse needs of all nations and regions has proven to be a challenging task [46].

Moreover, concerning the problem of "skills shortage", it is characterized by an imbalance wherein the demand for labor exceed the availability of workers at the prevailing market wage. Employers frequently cite challenges in recruiting suitably skilled workers, even when the workforce is relatively abundant. In certain cases, employers may conflate skills shortages with the incapacity to attract labor at existing wage rates or with skills deficiencies primarily stemming from inadequate training [47, 48]. Employers may equate shortages with internal skills deficits (current workers possessing suboptimal skills), denoting instances where existing workers lack adequate skills to perform their roles effectively [48, 49]. Furthermore, numerous employers allude to motivational or attitudinal shortcomings in their current or potential employees as skill deficiencies, emphasizing the significance of social skills alongside technical competence [50, 51].

Training and skills development is significantly lower in SMEs than in large enterprises – with SMEs involved in up to 50 percent less training than larger firms. The pool of SME workers requiring further education and training is significant. However, SMEs often find it difficult to support formal learning activities due to their small size. SMEs use both formal and informal training but they get better outcomes from informal training through use of knowledge intensive service activities (KISA). Training for highly skilled employees focused on productivity-enhancing skills (e.g. technical and management skills, entrepreneurship) and green skills [52].

2.1.4 Open trade for resilient supply chains

The European Commission identified 137 products for which the EU is highly dependent on external suppliers. About a quarter of these (34 products) are very vulnerable, given their low potential for diversification and substitution by EU products. The EU imports about half of these products from China (52 percent), followed by Vietnam (11 percent) and Brazil (5 percent). The Commission estimated that the EU is less dependent on the US than vice versa but both have important common dependencies vis-à-vis China. This particularly concerns critical raw materials and products needed for the green and digital transition [53].

The COVID-19 pandemic highlighted global supply chain vulnerability, but prior shocks like natural disasters, political instability, fuel crises, disease, terrorism, and cyber attacks had already raised concerns about resilience [54, 55, 56, 57]. Moreover, deliberate corporate strategies, such as the implementation of lean initiatives and single-sourcing policies, aimed at cost reduction and improved coordination, can inadvertently exacerbate the impact of disruptions by leaving supply chains with limited spare capacity

to handle unforeseen events [58, 59]. Consequently, these disruptions can result in substantial financial and operational losses for companies [60, 61, 62].

Supply Chain Resilience (SCRES) has been defined as "the ability to proactively plan and design the supply chain network for anticipating unexpected disruptive negative events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post robust state of operations, if possible a more favourable one than that prior to the event, thus gaining a competitive advantage" [62]. Another accredited definition describes SCRES as "the adaptive capability of a firm's supply chain to prepare for unexpected events, respond to disruptions, and recover from them in a timely manner by maintaining continuity of operations at the desired level of connectedness and control over structure and function" [63].

At the firm level a variety of strategies have been identified to enhance resilience, with a primary focus on increasing flexibility [64], establishing redundancy [65], fostering collaborative relationships within the supply chain [66, 67, 68], and enhancing supply chain agility [69].

Also public policies can play an important role in improving the resilience of companies supply chains. Specifically, political authorities have the power to shape the structures of supply chains by promoting practices such as shortening, reshoring, near-shoring, or diversification. Various measures can be adopted to encourage these practices, including subsidies, tax incentives, tariffs and local content requirements. Actually, a natural trend in this direction has already been observed. Indeed, the increase in wages in developing countries, the expanding role of services, and the impact of technologies such as automation and artificial intelligence (AI) have made it increasingly cost-effective and environmentally friendly to move production closer to customers.

Legal certainty in trade and investment frameworks help create a stable environment. Government agencies can boost resilience by implementing standardization, which increases opportunities for substitution of goods [70]. Also, special emergency measures, such as simplified customs duties and streamlined border processes for critical goods, can be implemented when disruptions occur.

Public funding may be used to help companies in strategic sectors monitor their supply chains, screen risks and develop potential disruption scenarios and ways to mitigate them. Indeed, underestimating or failing to anticipate the occurrence and consequences of an event can result in disruptions that have a substantial impact on supply chain operations [71].

All these actions involve contact with the private sector and, as such, public authorities need to establish information-sharing platforms, include firms' feedback in policy decisions and create partnerships with the private sector so that there is high responsiveness and clear division of responsibilities in case of supply chain crises [72, 73].

In light of the effective approaches that have just been detailed, the European Commission is committed to establishing a resilient supply chain through the fourth pillar of the EGD. Precisely, the formation of the **Critical Raw Materials Club**, serving as a platform to connect raw material consumers with resource-abundant nations, will secure the global supply chain by fostering a competitive and diversified industrial base. The EU seeks to enhance the exchange of green technologies and sustainable practices by **expanding Free Trade Agreements** and forging partnerships through trade. Simultaneously, regulatory measures will be employed to **prevent foreign subsidies from distorting competition within the Single Market**, particularly in areas related to clean technologies.

The Commission will also examine the specific case of SMEs, which may need targeted support. Indeed, they are particularly vulnerable to lock-in effects and high switching costs. At the same time, **due to limited resources, SMEs are often unprepared for supply chain disruptions**, with lasting negative consequences. Through the European Cluster Collaboration Platform and the Enterprise Europe Network, the EU aims to address disruptions and vulnerabilities and help SMEs diversify supply by connecting them with new partners [74].

2.2 Cleantech industry

The term cleantech is a relatively recent addition to our vocabulary, with its earliest usage tracing back to the mid-1990s within North America's venture capital community [75]. It is essentially a compound term comprising "clean" and "technology". In this context, "clean" alludes to the attribute of having minimal or no environmental impacts, while "tech", derived from "technology", denotes the tools and methods used to achieve these environmentally friendly outcomes. The following section will present some of the most accepted definitions for this new business and attempt to define the sectors that fall under it.

2.2.1 Definition

A review of the existing literature shows that there is still no globally accepted unambiguous definition of cleantech. Pernick and Wilder [76], define cleantech as "any product, service, or process that delivers value using limited or zero non-renewable resources and generates significantly less waste than conventional offerings". Shakeel and Juszczyk [77] share a similar view, defining cleantech as "technologies, products, or services that aim to reduce negative environmental impact by enhancing efficiency, minimizing waste, promoting the use of sustainable resources, and protecting the environment". According to Koch, Sørensen, and Wildner [78], cleantech encompasses activities aimed at advancing, manufacturing, or implementing new or improved processes or products related to renewable energy and materials. It also involves optimizing resource utilization and enhancing energy efficiency, all while reducing the consumption of natural resources and overall pollution.

The European Union's practical guide offers a comprehensive definition defining cleantech as any process, product, or service that reduces negative environmental impacts. This reduction can be achieved through environmental protection activities, sustainable use of natural resources, or the use of goods specifically modified or adapted to be significantly less energy or resource-intensive than the industry standard [79].

On the other hand, several sources point to the pragmatic definition provided by the Cleantech Group, which underscores the economic viability of cleantech innovations. The Cleantech Group characterizes cleantech as an extensive spectrum of "new technologies and related business models that offer competitive returns for investors and customers while providing solutions to global challenges" [80].

While these definitions vary somewhat in scope, they generally refer to the same concept: **a technology (encompassing technologies, products, materials, processes, business models, or related activities and systems) designed to achieve environmentally friendly outcomes, specifically having minimal or relatively limited effects on the environment** [81].

The broadness of the term "cleantech" poses challenges when trying to define what falls under the category of cleantech and what should be excluded. At least these three limitations should be considered when classifying cleantech [75]:

1. Use-centric labeling: cleantech products are often labeled as such based on their use. However, little attention is given to how these technologies were manufactured, the materials used, or whether the company's overall operations and processes align with clean principles. Similarly, at the end of a technology's life cycle, there is often a lack of consideration regarding whether mechanisms were in place for environmentally friendly recycling or disposal.

2. Context sensitivity: a technology that contributes to cleaner outcomes in one context may yield different results when applied in a different setting. For example, microchip production for renewable energy systems can be categorized as cleantech, but when the same microchips are used in the coal industry, their environmental friendliness may be in question.

3. Baseline comparison: currently, a technology is considered cleantech if it performs cleaner than the incumbent technologies. This means it must outperform the dirtiest alternative available as a baseline. However, this approach makes categorization difficult, as the actual environmental impact can vary based on the nature, scope, and current state of the sector.

2.2.2 Taxonomy

Cleantech, as defined by the Cleantech Group, encompasses a wide range of sectors such as energy & power, resources & environment, transportation & logistics, agriculture & food, enabling technologies, and material & chemicals [82]. This broad inclusivity means that **companies from various industries can be considered part of the cleantech sector, leading to multiple efforts to classify these industries accordingly**.

Cumming, Henriques, and Sadorsky [83] and Cumming, Leboeuf, and Schwienbacher [84] highlight four dominant industries: energy, transportation, water, and materials. They also discuss various energy-efficient technologies like renewable energy, recycling, and green chemistry. Hansen [85] identifies five primary industries within cleantech: renewable energy, smart grid, green construction, transportation, and waste and water management. Binz, Tang, and Huenteler [86] focus on similar categories emphasizing their rapid development and discussing specific advantages for early movers in manufacturing and knowledge creation. A more detailed categorization, as outlined by Gray and Caprotti [87], includes industries such as renewable energy, carbon capture and storage, green IT, sustainable construction, and smart and electric transportation. These industries often intersect with government services and align with national and local policies.

In particular, the EIBURS reserch team preferred to develop a categorization of cleantech companies inspired by the one made by Haščič and Migotto [88], in which technologies are classified based on their contribution to environmental sustainability. These authors, in turn, utilized as a reference a classification encompassing 80 technological fields covered by the ENVTECH search strategies of the OECD. Specifically, the categories identified are:

1. Environmental management
    (a) Air/water/soil pollution abatement/remediation
    (b) Waste management
2. Resources preservation
    (a) Water conservation/availability
    (b) Sustainable agrifood technologies
    (c) Sustainable raw materials

3. Industrial energy management
    (a) Sustainable energy production
    (b) Sustainable fuels
    (c) Energy-efficient industrial technologies
4. Capture, storage, sequestration or disposal of GHG
5. Sustainable modes of transport
6. Energy management of buildings
7. Others categories

Chapter 3

Methodology

The methodology chapter introduces the techniques used in the development and administration of the survey. Firstly, to elucidate the rationale behind the survey's structure, an outline of the objectives of the CLEU project will be provided. Next, the different sections and individual questions will be presented. Additionally, the strategies used to contact participants and collect data will be detailed.

3.1 Survey development guidelines

A survey is a valuable research tool for collecting qualitative or quantitative data by directly questioning individuals in a sample from a larger population [89]. In particular, surveys offer several advantages, including cost-effectiveness, suitability for describing characteristics of large populations, versatility in administration methods, the ability to address numerous questions on a subject, and ease in achieving high reliability in data collection [90, 91, 92]. However, the quality and credibility of the results are strongly linked to the response rate.

Survey design plays a critical role in enhancing response rates [93]. In the survey examined in this thesis, **closed-ended questions**, forcing respondents to choose from a provided set of responses, have been preferred [94]. However, although it's observed that most respondents select from the given responses when encountering this question type [95], considering the continuously evolving nature of the assessed topic, **it has been decided to offer respondents the option to select "Other" and provide additional insights**. Meaningful labels have been applied in the cases of Likert and dichotomous scales [96].

Several strategies have been implemented to avoid response bias, which emerges when participants provide responses that do not accurately reflect their true abilities, beliefs, and behaviors. Specifically, the structure of the questions was designed to prevent respondents from incurring social desirability bias—overstating their own favorable characteristics and behaviors or avoiding admission of those that might portray them in a negative light.

Questions involving double negatives have been avoided. The question wording has been kept as simple as possible, precluding alternative interpretations or incomplete sentences that could allow misinterpretation [95, 97, 98]. Questions have been posed, giving respondents all the instruments and knowledge they need to answer, allowing them to express their thoughts in a conscientious and responsible way.

3.2 Survey structure

The survey is provided in its entirety in the appendix A.1. This section is intended to present an overview of its structure and the questions it contains.

The survey comprises 22 mandatory macro questions and 4 optional final questions, giving respondents the option to provide personal data if they wish to be interviewed in the future. Additionally, certain questions serve as selection mechanisms: for instance, question 1 prevents those not in the cleantech sector from completing the entire survey, and question 6 allows only those involved in the development of cleantech technologies to answer specific subsequent questions on innovation. The various questions are categorized into five main sections: "Introduction", "The company", "Innovation", a central body dedicated to the four pillars and "The responder".

The introduction aims to familiarize invited participants with the survey's subject matter, as ensuring that respondents are correctly identified and are aware of the study and its objectives helps to improve the response rate [99, 100]. Firstly, to enhance the response rate, credibility and reliability are established [101, 93] by acknowledging the project's coordination and sponsorship from Politecnico di Torino, Politecnico di Milano, and the University of Bologna in collaboration with the EIB and the EIF. It provides essential information about data handling to address privacy concerns and aims to motivate respondents by emphasizing the importance of their participation and the value of their contributions: the survey's responses play a pivotal role in assisting the EIF and the EIB to further develop their support for the cleantech field and contribute to the development of the European cleantech ecosystem. Additionally, in return for their responses, respondents will receive a report on the survey results, as incentives have been proven to be very effective in increasing response rates [101].

However, participants often lack a strong commitment to complete the survey accurately, leading them to answer questions randomly, read them less carefully, or even abandon the survey. This behavior introduces significant bias into the collected data. To secure cooperation from businesses and specific survey participants, the act of responding to a questionnaire should be considered a form of social exchange [102]. To facilitate this, considerable effort has been made to minimize respondent costs by reducing mental effort required, minimizing opportunities for embarrassment, and ensuring brevity [103]. The completion time is expected to be approximately five minutes.

In **The Company** section, information about participating companies is gathered that isn't accessible through existing databases like Orbis and Pitchbook. Specifically, inquiry is made about the company's involvement in the cleantech sector, delving into its history (question 1) and the driving forces behind its operations within this sector (question 2). The goal is to understand whether companies are undergoing a structural change to make their entire business "future-proof" or if the implementation of transformative climate and innovation actions targets specific business units and operational sites. Subsequently, investigation focuses on the difficulties the company faces (question 3) and the levels of technological, market, and regulatory uncertainty it must endure (question 4) as it operates in a green and innovative sector. Additionally, the degree of commitment to the EGD is assessed based on the actions companies have taken to achieve the ultimate goal of reaching climate neutrality by 2050 (question 5).

Next, three questions included in the **Innovation** section were crafted exclusively for companies dedicated to developing cleantech technologies (i.e., innovators). These questions aim to assess the level of technological readiness of the company's core clean technology incorporated in its main project (question 6), discover the recent research and innovation activities undertaken by the company (question 7), and understand the preferred approach to safeguarding the cleantech intellectual property resulting from

these activities (question 8).

In light of the survey's primary objective, which is to acquire a comprehensive understanding of the performance of European cleantech companies in relation to the four pillars of the EGD and to identify potential enhancements in the conditions under which they operate, the core of the survey is organized into four distinct thematic sections. Each section is exclusively devoted to the examination of one of the pillars, namely: predictable and simplified regulatory environment, faster access to funding, enhancing skills, and open trade for resilient supply chains.

- The **Regulatory Environment** subsection investigates how much certain listed policy and regulatory areas are affecting the business (question 9), along with their related undesirable effects that could be mitigated in the future (question 10). Additionally, it seeks suggestions for regulations and policies that could most effectively promote technological development from the company's perspective (question 11). The subsection also inquires about the company's perception of specific regulatory aspects, such as the clarity of current policy features (exceptions, scope, related monitoring activities, etc.), the clarity of objectives, and their perceived enforceability (question 12).
- The **Access to Funding** subsection delves into the company's willingness to raise funds (questions 13a and 13b) and the intended allocation of these funds to cleantech activities (question 13c). It also aims to identify the primary challenges faced in participating in public funding programs (question 14) and assesses the company's inclination to utilize alternative financing instruments (question 15).
- In the **Skills** subsection, there is an inquiry into the skills required by the company and whether these skills will be outsourced, internally provided, or already available. This encompasses a broad spectrum of skills, including technical, managerial, and soft skills (question 16).
- The **Supply Chain** subsection is designed to gather information about the localization of suppliers (question 17) and the factors influencing their selection (question 18). Additionally, it seeks insights into government policies that could potentially enhance supply chain resilience (question 19) and the specific actions the company is considering to strengthen its supply chain resilience (question 20).

The concluding section, **The Responder**, is intended to solicit subjective opinions from companies regarding the design and feasibility of the goals outlined in the EGD (questions 21 and 22). Moreover, as a means to enable future communication, respondents are provided with the opportunity to furnish their name, surname, position in the company, telephone number and personal email (questions from 23 to 26). Following suggestions from the literature, the demographic questions are intentionally limited and positioned at the end of the survey. This approach aims to prevent disruption to participants' focus with off-topic questions in the middle. While an alternative could have been to place them at the beginning, their non-mandatory nature led to the decision to position them at the end, ensuring a higher completion rate for the critical questions.

The survey has been pretested with three sample companies and feedbacks has been incorporated for survey refinements.

3.3 Population and sample selection

The initial phase of the CLEU research project involved the development of a dataset containing financial accounting data, patent records, and funding sources for European cleantech companies [104].

Given the lack of a universally accepted definition for Cleantech, the research team has devised a robust and replicable methodology for identifying European Cleantech companies within a vast database. The initial phase of this process began with the Bureau van Dijk's Orbis database, a business database containing information on over 40 million companies worldwide. From this extensive dataset, the researchers narrowed down the initial sample to 537,129 companies that fulfilled the following criteria:

- Being located within Europe;
- Possessing recorded accounting data for a minimum of one business year;
- Having an accessible extended business description.

The following selection process involved three distinct steps, outlined as follows:

1. Initially, a supervised machine learning (ML) algorithm was applied to the extended business descriptions obtained from Orbis to eliminate companies that clearly did not fall within the Cleantech category. As a result, the sample size was reduced to 74,047 companies.
2. Next, a computer-aided filter was employed on the Orbis descriptions. This iterative process relied on keyword queries to identify potentially true positive Cleantech companies. This step further reduced the sample to 23,858 companies.
3. Finally, the 23,858 Cleantech companies were manually classified. Among them, 2,990 companies were labeled as "Cleantech innovators", emphasizing their dedication to the development of clean technologies. The remaining 20,868 were labeled as part of the "Cleantech ecosystem", signifying their involvement in Cleantech technologies through various means, such as adoption, provision of services or input for Cleantech technology development.

Following the release of Report "Using machine learning to map the European Cleantech sector" [104], an additional 1,178 companies have been identified and subsequently incorporated into the survey target dataset for this thesis. **This brings the total number of target companies to 25,036**.

3.4 Survey administration

Only for 15,034 of the 25,036 companies identified was possible to identify at least one valid e-mail address in the dataste Orbis and Pitchbook. In some cases, several valid email addresses were found for the same company. This led to a total of 22,169 contacts.

The research team opted to employ the **Qualtrics experience management platform** for survey administration. Qualtrics is an cloud-based platform for creating and distributing web-based surveys, widely used for academic research and market research. Among the reasons it was chosen are:

- Multiple sharing settings make it easy to collaborate with colleagues on surveys;
- Advanced conditional logic tools allow for user-tailored survey paths;
- Built-in email distribution capabilities: it can send reminder emails to non-responders and thank-you emails to responders;
- The ability to export data as an SPSS data file (.sav), comma-delimited file (.csv), text file (.txt), HTML, or XML [105];

Distribution of the survey began on July 18, 2023, and ended on October 15, 2023. Multiple waves of mailings and reminders are critical in encouraging responses [106], for this reason during this extended time frame, emails were systematically sent about twice a week, mainly on Mondays and Fridays. Monday stands out as the preferred day for survey dissemination due to the greater responsiveness of employees on this particular day [107, 108]. In contrast, although Friday is not considered the optimal day for survey dissemination, a strategic decision was made to send an additional reminder on this day. This additional Friday reminder served to encourage timely and full participation in the survey, stimulating survey completion by the end of the week, especially for those who had initiated the survey process on previous days.

During the final week that the survey was open for reporting, all users with a completion rate exceeding 30 percent were identified. Subsequently, each of these was individually contacted with the purpose of urging them to finalize the survey. The email sent, as detailed in the appendix A.2, provided each user with a breakdown of the remaining unanswered questions, emphasizing the minimal time required to make a meaningful contribution to the project.

Figure 3.1 shows the number of surveys started per day (represented by blue vertical bars) during almost three months of sending out invitations. As expected, immediately after a wave (indicated by pink vertical lines) of sendings, there is a peak in the number of starts, which gradually decreases over time. The blue dotted line represents the trend of surveys started per day, which approaches 0 by the closing date of the survey.

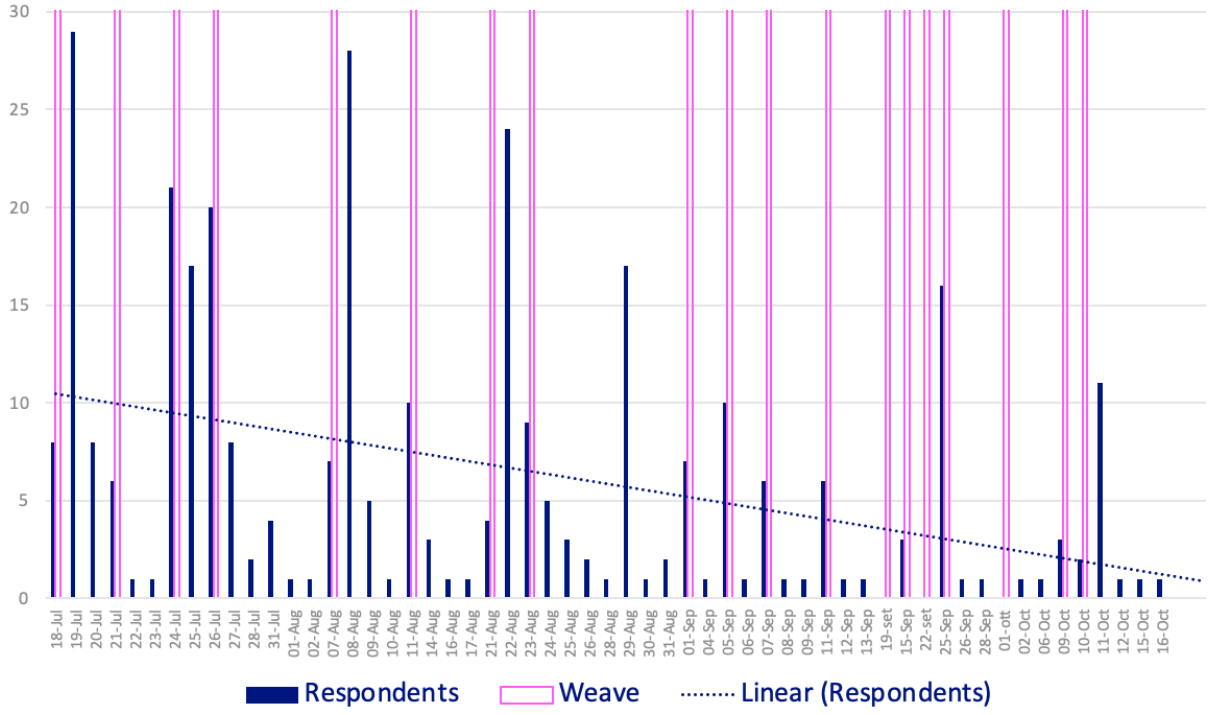

Figure 3.1: Survey started per day [own elaboration].

It turns out that some email addresses were unreachable, being labled by Qualtrics as blocked,"hard bounce" and "soft bounce". Hard bounces are emails that can't be delivered due to a permanent reason. This could include the email address not existing, the recipient server not accepting emails, or the domain not being a real email domain. Soft bounces are emails that can't be delivered due to temporary reasons. The recipient email inbox could be full, the email could be too large, or the recipient email

server could be temporarily down. Qualtrics automatically retries sending soft bounces after a period of time [109]. Therefore, **13,457 companies have been reached**. The figure 3.2 summarises the process leading to the identification of the final sample.

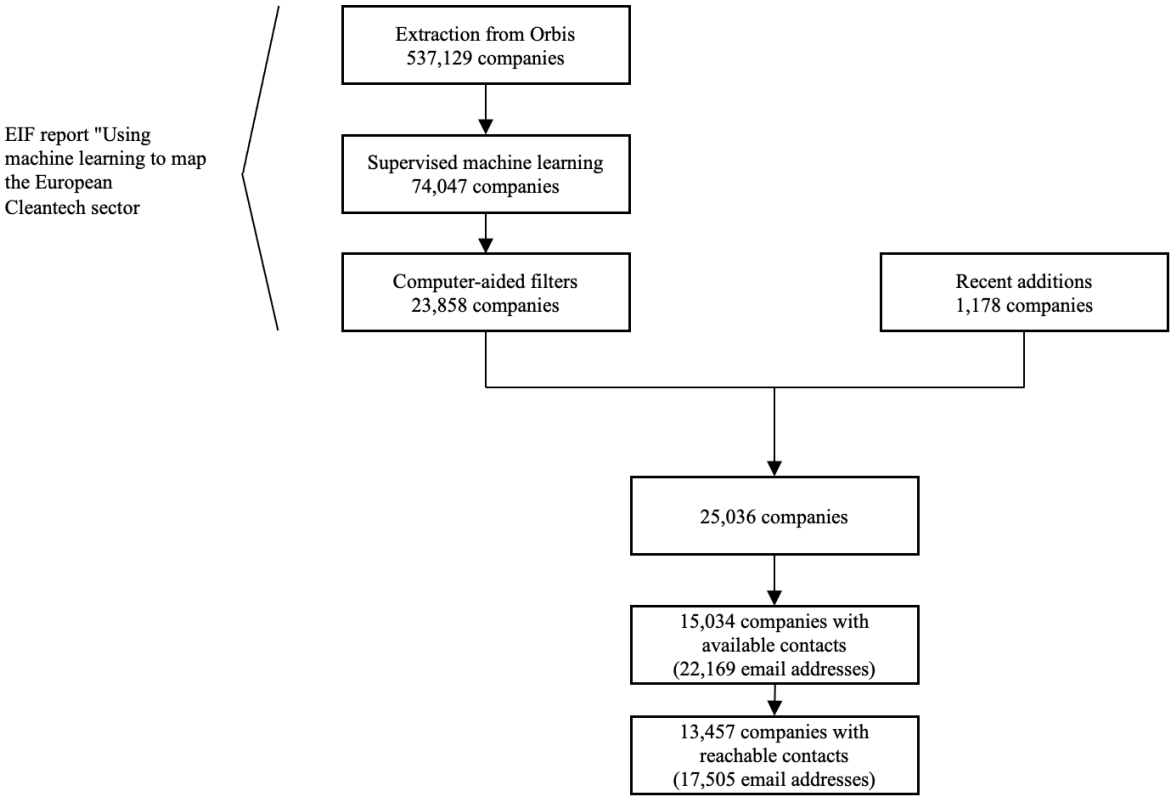

Figure 3.2: Companies targeting process [own elaboration]

3.5 Sample description

For 29 of the companies, determining the country of location, incorporation year, technology category, and sector in which the business operates was not possible. These companies constitute 0.2 percent of the sample, and the absence of this information is not expected to significantly impact the reported data's quality. To maintain data integrity, companies with missing information were proportionally redistributed. To illustrate, consider the case of the UK: out of 165 identified companies, 113 were classified as ecosystem companies, 46 as innovators, while data for 6 companies was unavailable. For representational purposes, 4 companies (70 percent of 6, i.e., 113/165 multiplied by 6) were designated as ecosystem companies, and 2 as innovators.

As seen in the Figure 3.3, Germany significantly outperforms all other nations in terms of both the number of companies in the ecosystem and innovators. France, Poland, and Italy are also among the top 5 countries with the most companies in both categories. The Czech Republic stands out, particularly for its substantial contribution to ecosystem companies, while Spain stands out for its contribution to the innovators category. In contrast, Malta, Ireland, Montenegro, Cyprus, and Albania each have fewer than 10 cleantech companies.

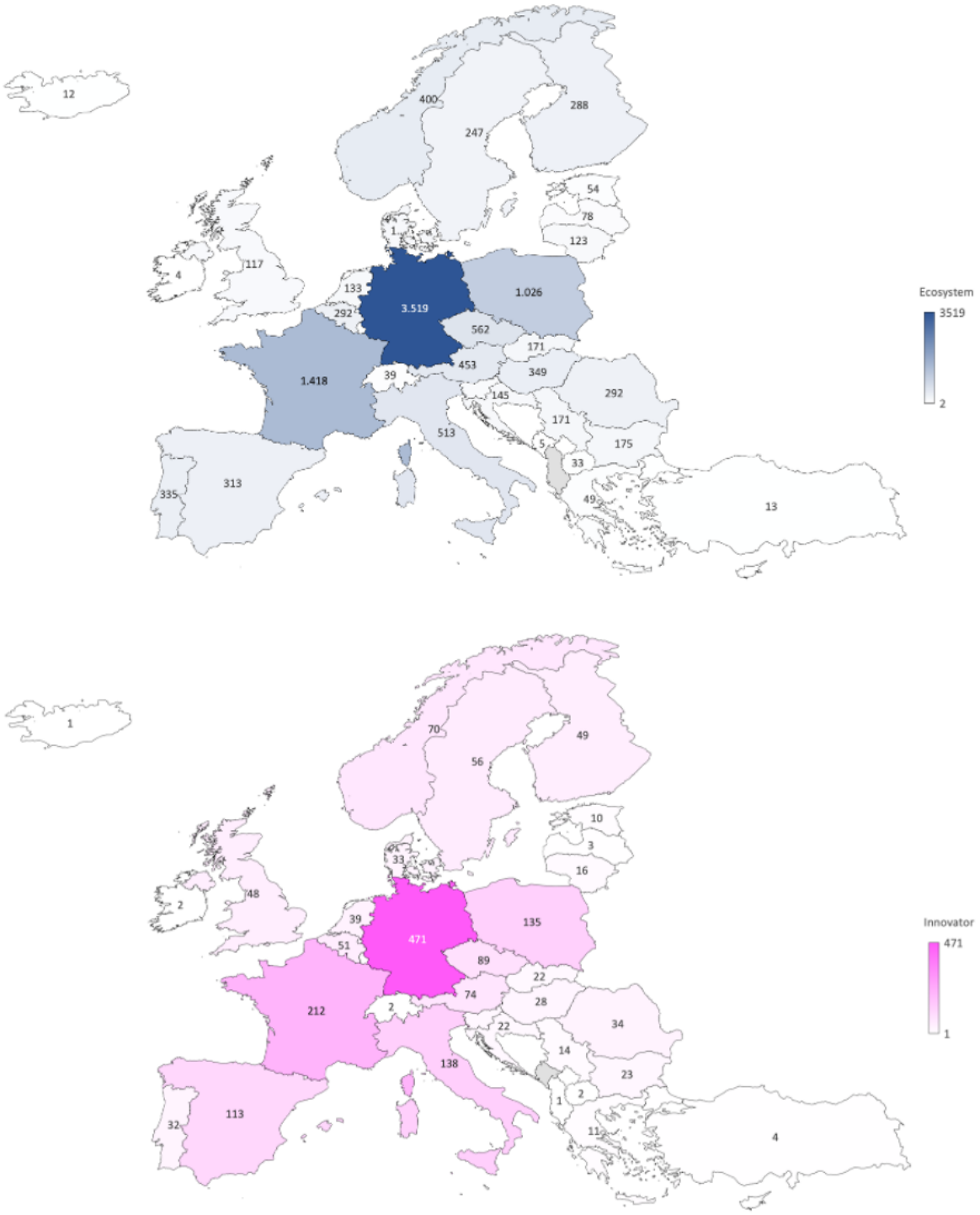

Figure 3.3: Ecosystem companies and innovators by country [own elaboration]

Less than 5 percent of the companies in the sample, approximately 500, were incorporated before 1940. In the subsequent years, the number of incorporated companies steadily increases. Specifically, those incorporated between 1961 and 1980 constitute 11 percent of the sample. The peak was reached in the period 1981-2000, with as many as 5,394 companies belonging to the ecosystem and 697 innovators, accounting for 45 percent of the sample. More than a third of the representatives in the sample, precisely

36 percent, were incorporated in the last two decades (Figure 3.4).

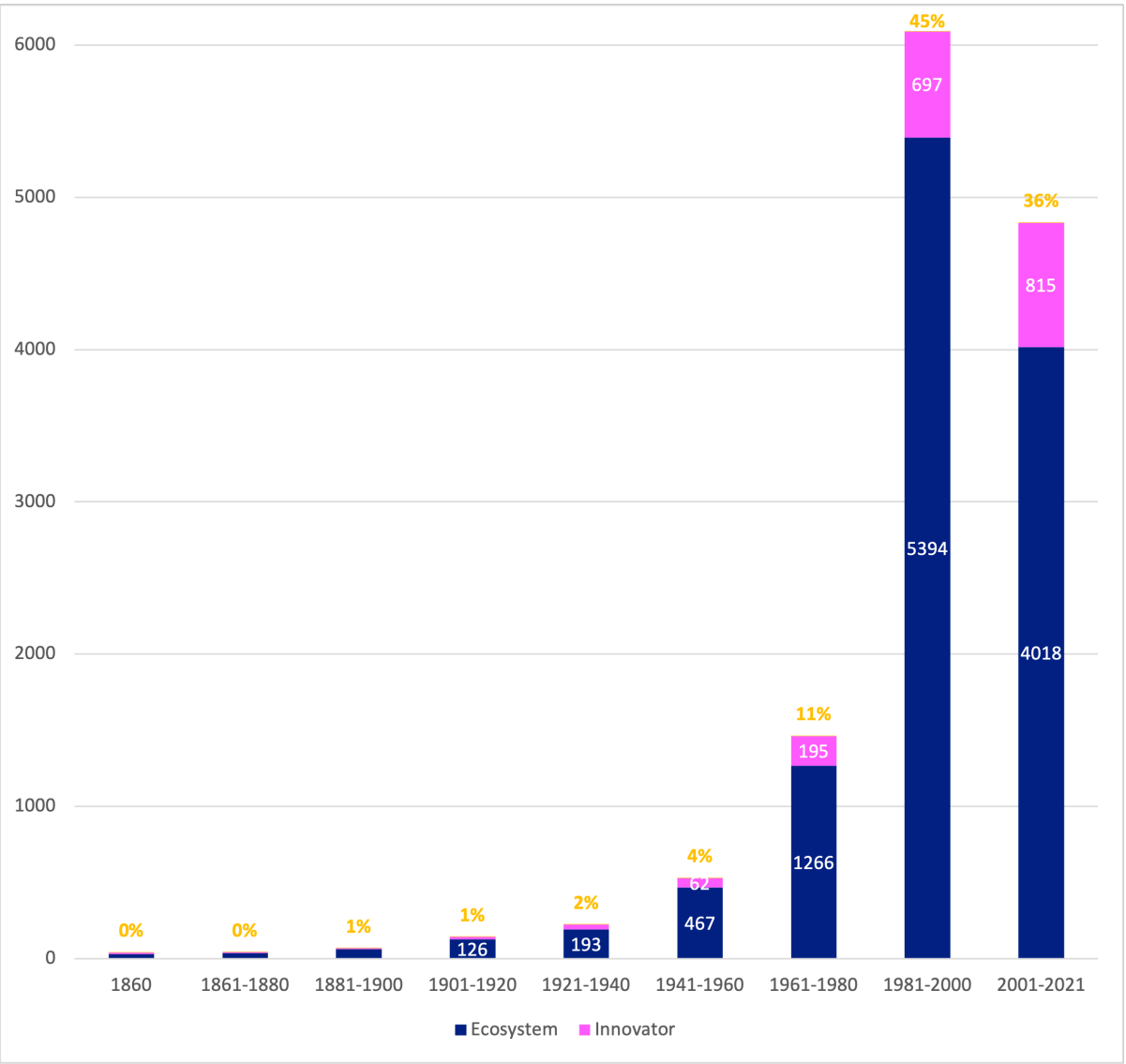

Figure 3.4: Ecosystem companies and innovators by year of incorporation [own elaboration]

Figure 3.5 divides the 13,457 companies in innovators and companies adopting the technology, offering related services, or supplying inputs for its development. Specifically, the latest are divided into 5 different groups:

- Experimenters: companies performing experimental tasks that can lead to discoveries and advances in the science of the cleantech supply chain;
- Manufacturers: companies producing necessary and auxiliary components or raw materials to the clean technology;
- Distributors: companies distributing or being involved in the commercial provision of clean technologies,
- Integrators: companies dealing with engineering, installation, procurement, design, conception, and planning. Their prominent role is to make the clean technology ready to use for the adopters;

- Operators: companies dealing with the construction, implementation, and maintenance of facilities where clean technology is used. In addition, adopters who use technology as the primary tool to achieve their output (e.g. energy production) are also considered operators.

With the exception of experimenters, constituting 1 percent of the sample, the remaining categories demonstrate a comparatively substantial representation, ranging between a quarter and a sixth of the total sample approximately.

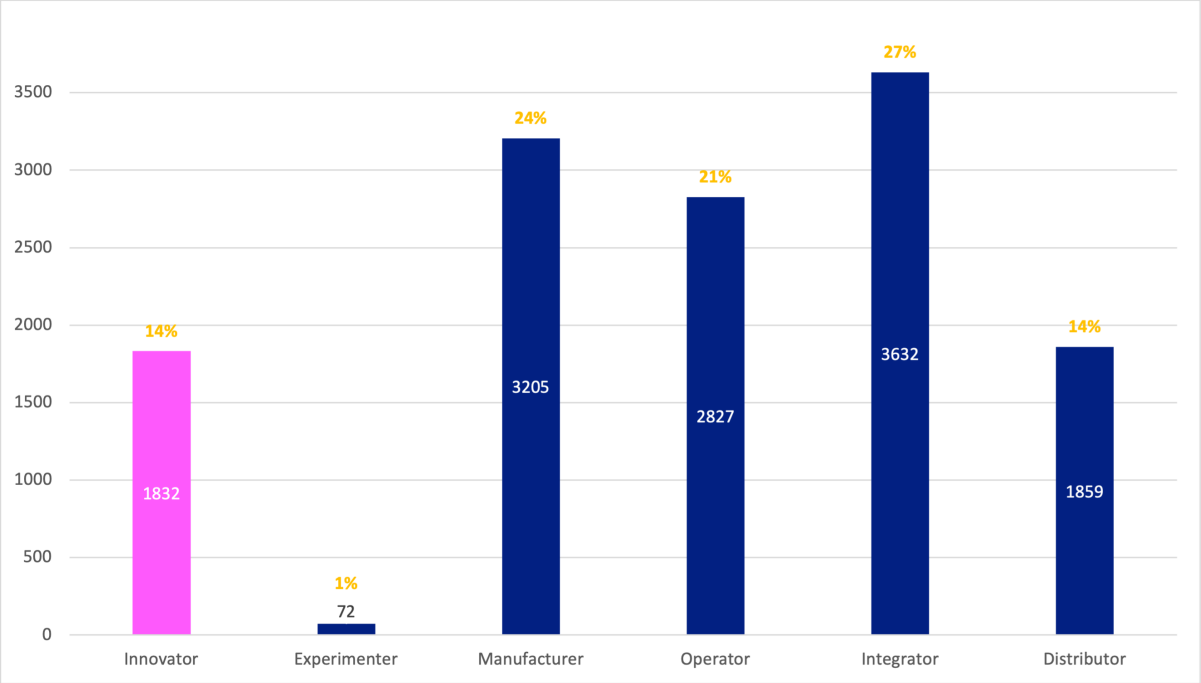

Figure 3.5: Ecosystem companies and innovators [own elaboration]

Additionally, in Figure 3.6 the companies are classified into the 7 different technological categories and 12 sub-categories presented in *Paragraph 2.2.2* according to their contribution to environmental sustainability. A company may be involved in one or more sub-categories.
About one-third of the companies in the sample engage in environmental Management, either through air, water, soil pollution abatement or remediation (22 percent) or waste management (18 percent). Another third of the companies are involved in industrial energy management, encompassing sustainable energy production (20 percent), sustainable fuels (5 percent), and energy-efficient industrial technologies (13 percent). Following this, there are companies dedicated to resources preservation (11 percent) and energy management of buildings (8 percent). Sustainable modes of transport (1 percent) and the capture, storage, sequestration, or disposal of greenhouse gases (almost 0 percent) have minimal representation in the sample. Additionally, some companies (2 percent) operate in sectors not explicitly covered in the aforementioned categories.

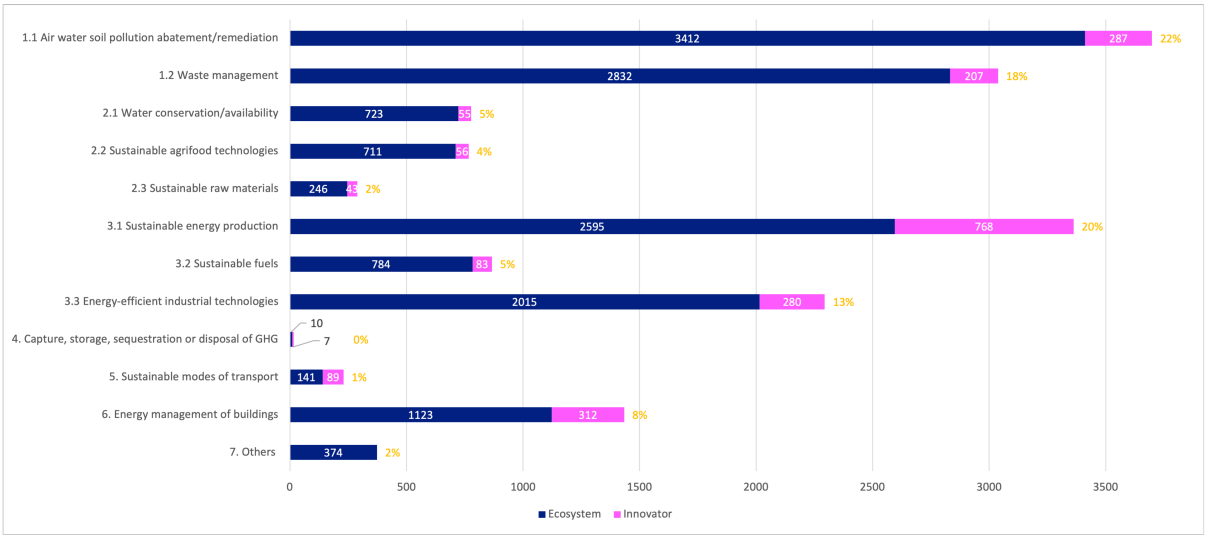

Figure 3.6: Ecosystem companies and innovators by technological categories [own elaboration]

Chapter 4

Discussion

This chapter presents the results of the survey. First, considerations will be made regarding the quantity and quality of the responses collected. Achieving high response rates is essential in order to draw meaningful conclusions from the data [110] and a good response rate serves as an indicator of how well planned and developed a study is [92]. Afterward, graphical representation will illustrate the obtained answers for each question, accompanied by additional comments.

4.1 Collected Data

A total of 332 people initiated the questionnaire. However, the data analysis will exclusively consider responses from individuals who completed the questionnaire in its entirety, amounting to 169 answers from 159 distinct companies. Specifically, for 5 companies two separate answers were contributed by different employees.

Unfortunately, there is a concerning trend of decreasing response rates over time, with a significant decline observed starting from 2001 [111]. Several factors appear to contribute to this trend. Firstly, both companies and individuals are increasingly being inundated with survey requests, resulting in a reluctance to collaborate. Business managers, in particular, are being overwhelmed by surveys that utilize the same mailing lists provided by professional societies, consulting organizations, universities, and government entities, leading to a higher level of respondent fatigue. Alternatively, it is possible that the individuals included in these lists may not always be suitable for the specific surveys being conducted. For instance, some potential respondents may lack the necessary experience or knowledge to provide relevant input. Furthermore, the pool of available management personnel is shrinking due to activities like downsizing and the implementation of lean practices [92]. Response rates can also be influenced by the perceived importance that respondents attach to the study and its underlying topics [92]. Additionally, some respondents may be hesitant to participate due to concerns about providing confidential information.

Of the 159 companies 37 are innovators (23 percent), the remaining 122 belong to the cleantech ecosystem (Figure 4.1). In particular, one third of the respondents are manufacturers, but it should be remembered that this is the largest category within the sample. Indeed, comparing these figures with those from the sample (Figure 3.5), it can be inferred that the response rate is 0 percent for experimenters; approximately 1 percent for operators, integrators, and distributors; 1,5 percent for manufacturers and 2 percent for innovators.

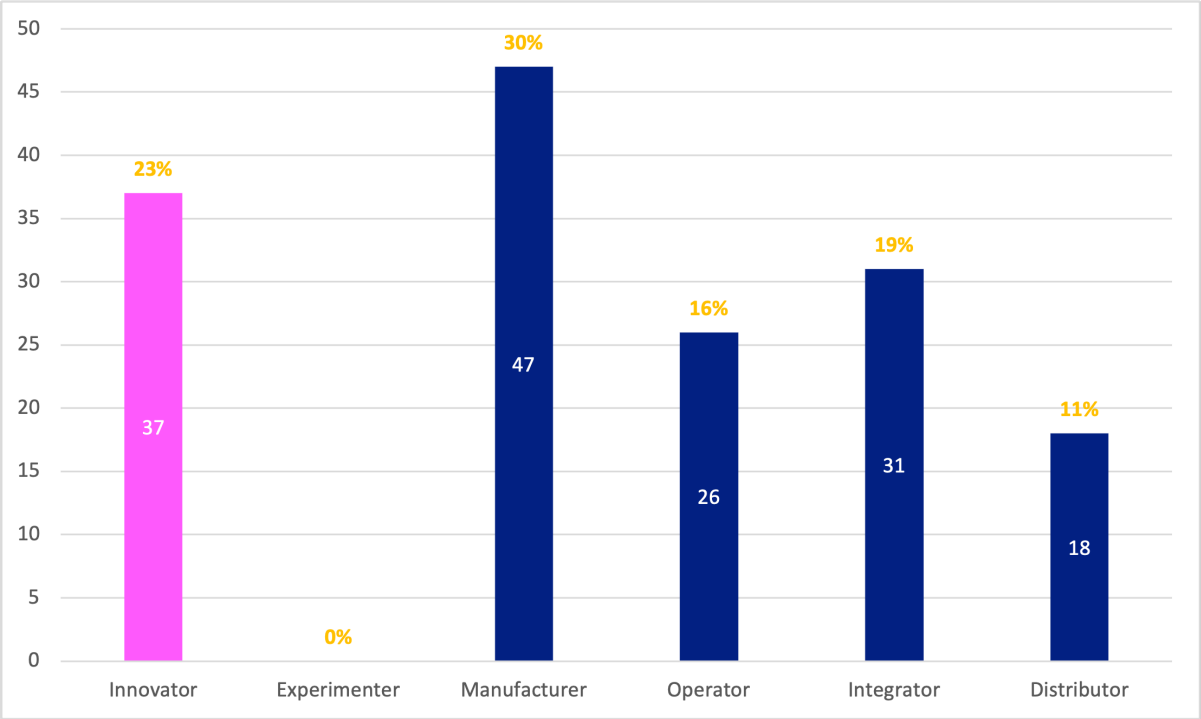

Figure 4.1: Ecosystem companies and innovator respondents [own elaboration]

Companies from 25 different European countries participated in the survey. The most participative nations are Italy, Sweden and Germany, which together contribute one third of the responses. Austria, Belgium, Poland, France and Norway also contributed significantly. In contrast, only one response each was collected for Denmark and Slovenia. Also, despite reaching out to companies in Switzerland, Iceland, Malta, Turkey, Montenegro, and the Republic of Ireland, none of them replied. In terms of response rate per country, Estonia stands out with a response rate of 8 per cent. North Macedonia, the United Kingdom, Sweden and Luxembourg followed with a response rate of around 5 percent (Figure 4.2).

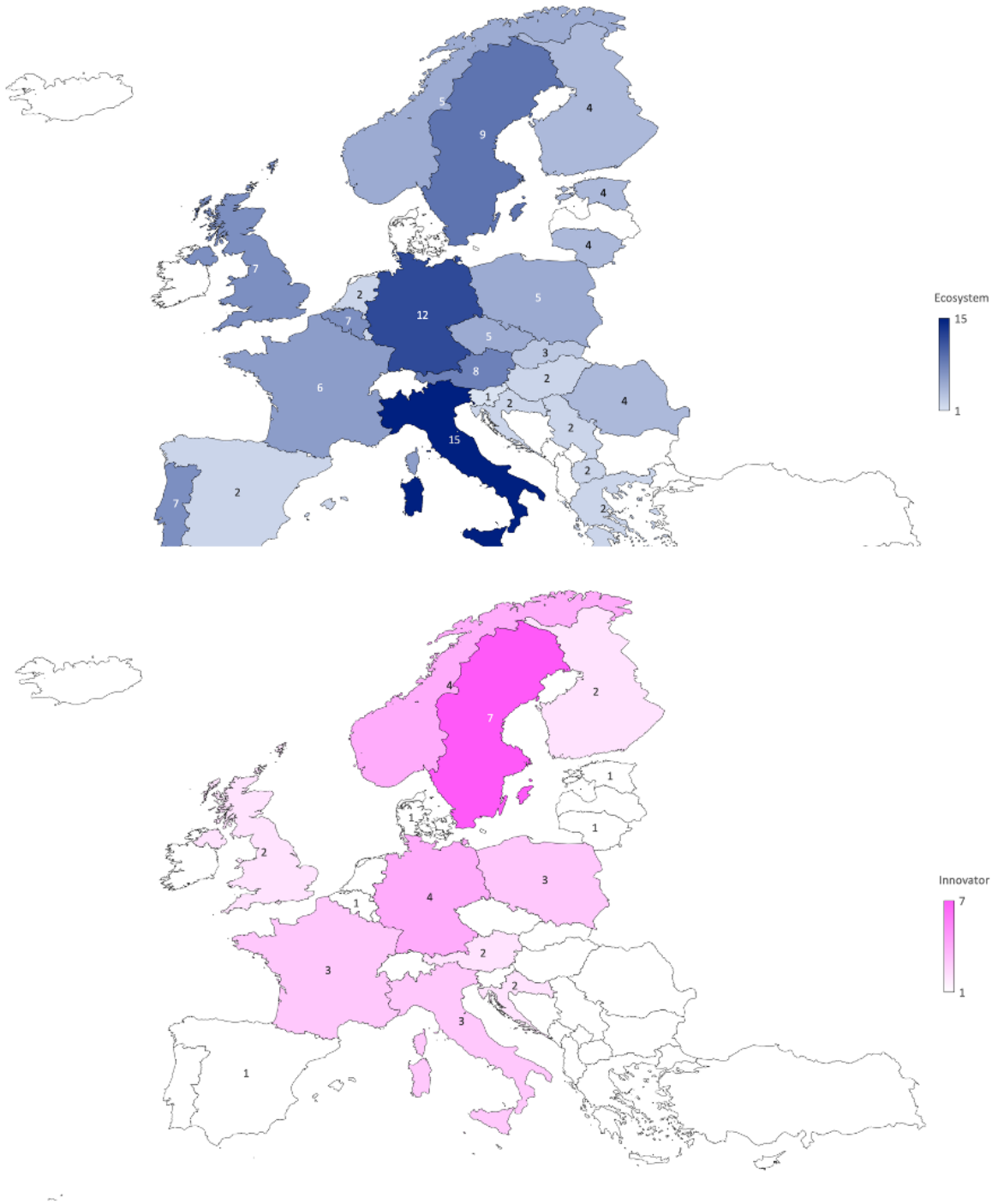

Figure 4.2: Ecosystem companies and innovator respondents by country [own elaboration]

As reported in Figure 4.3, almost 40 percent of the respondents are involved in energy management activities, including air, water ans soil pollution abatement or remediation (21 percent) and waste management (17 percent). Another 44 percent are engaged in industrial energy management, specifically sustainable energy production (25 percent), sustainable fuels (7 percent), and energy-efficient industrial technologies (12 percent). In terms of response rate, the limited number of companies in the sample

that dealt with the capture, storage, sequestration, or disposal of GHG demonstrated high participation, achieving a response rate of 18 percent. Excluding these, the response rate for other sectors was relatively consistent, ranging between 1 percent and 2 percent.

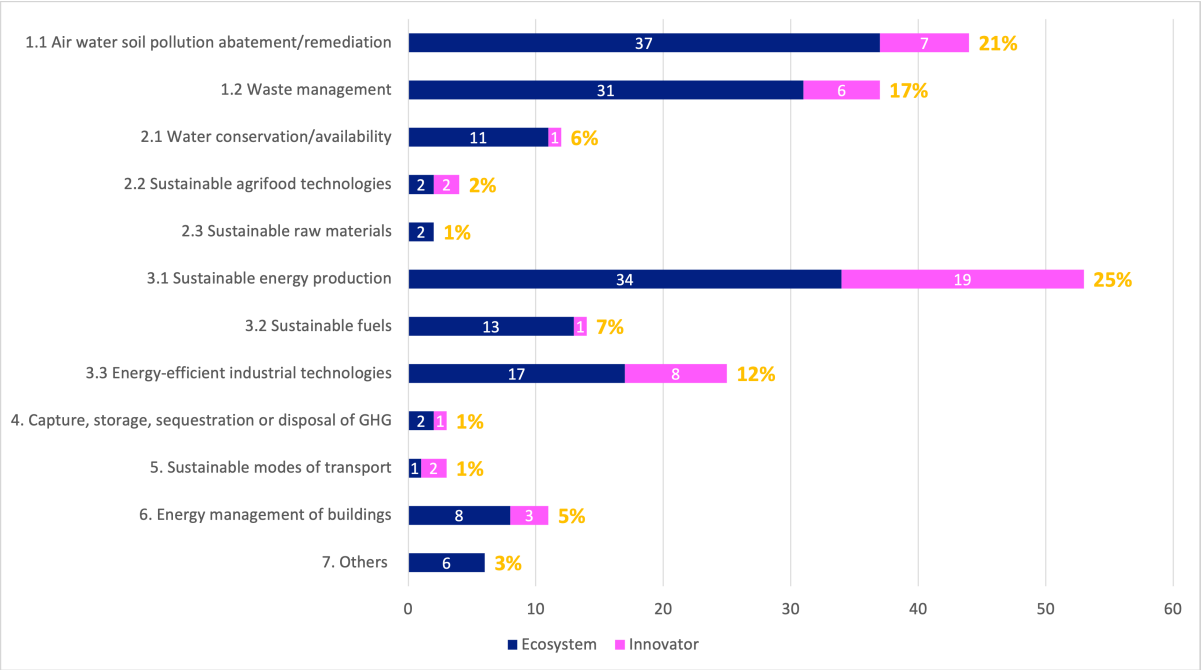

Figure 4.3: Ecosystem companies and innovators by technological categories [own elaboration]

Younger companies were found to be more participative, with almost all responses coming from companies established after 1980. In particular, 35 percent of them were established between 1980 and 1999, while 51 percent were established after 2000. (Figure 4.4).

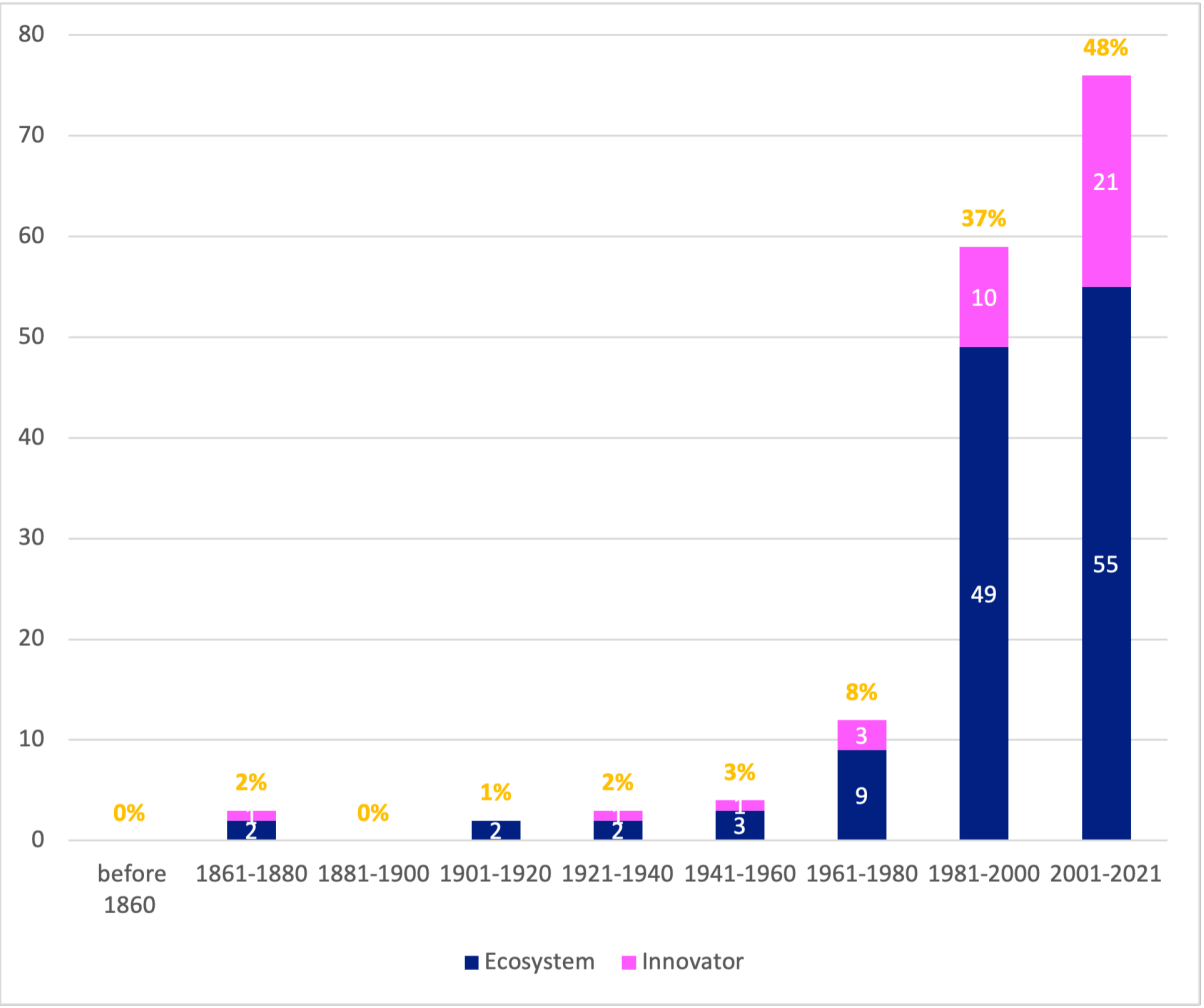

Figure 4.4: Ecosystem companies and innovator respondents by year of incorporation [own elaboration]

4.2 Statistical analysis of survey results

Question 1

The first question of the survey serves a dual purpose. First, it filters for companies operating in the cleantech sector (excluding false positives), and second distinguishes companies that have always operated in the cleantech sector (85 companies) from those that have transitioned into cleantech partially (45 companies) or entirely (7 companies) over time.

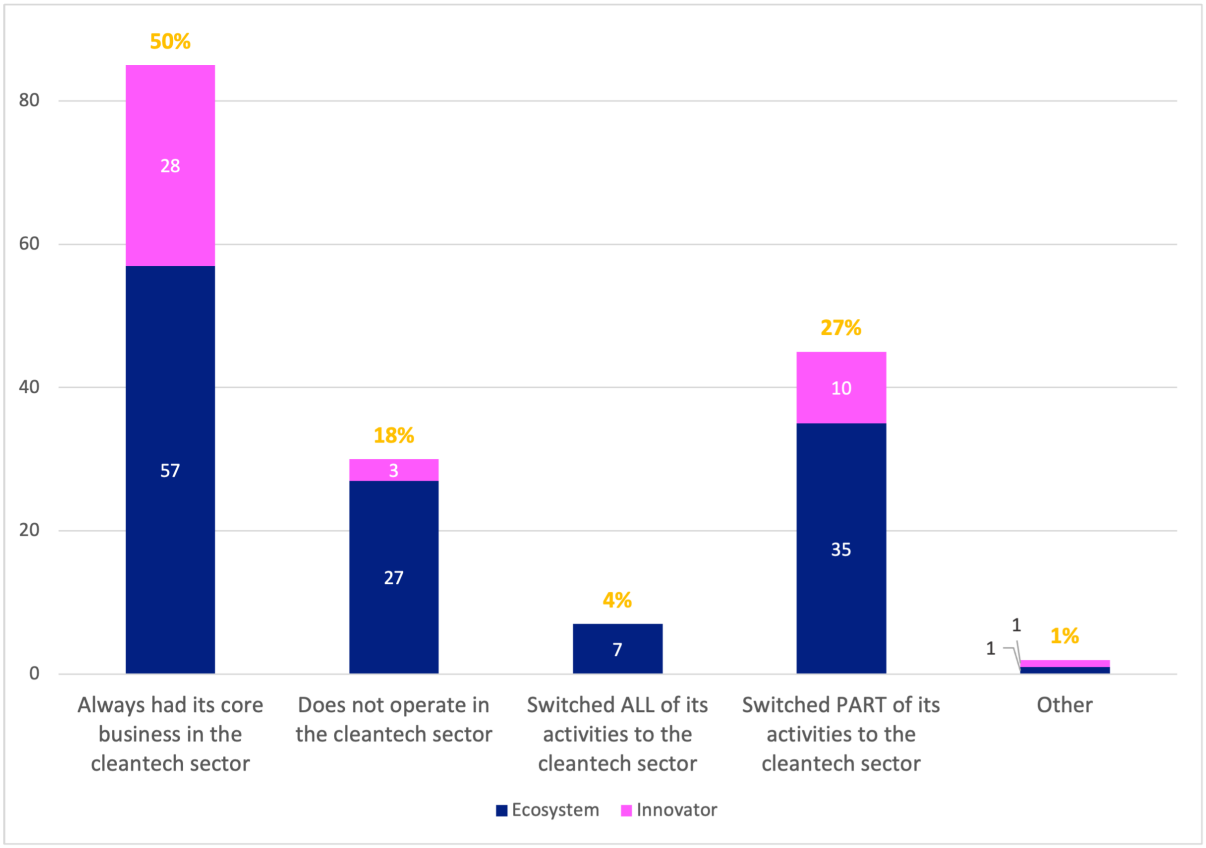

Figure 4.5: Question 1: Concerning the decision to operate in the cleantech sector, which of the following statement is mostly appropriated? (1 choice) - answers [own elaboration]

Among the participants, 27 companies from the ecosystem and 3 of those identified as innovators, indicated that they were not operating in the cleantech sector. Consequently, they were excluded from the subsequent survey questions. As a consequence, **all the statistics presented in the following pages pertain to 139 companies**.

Question 2

The second question allows companies to choose up to three primary motivations for operating in the cleantech sector.

As reported in Figure 4.6, most of the companies stated that operating in the cleantech sector is an integral part of their company's mission and vision (73 percent). The 59 percent recognized promising business opportunities in the sector, while the need for compliance with regulations and standards (27 percent) ranked third as a driver for companies to enter the cleantech sector. For about one-fifth of the respondents, band reputation (22 percent) and financial reasons (17 percent) were determining factors. In contrast, public sector incentives (11 percent) and pressure from stakeholders (9 percent) were among the less common motivations.

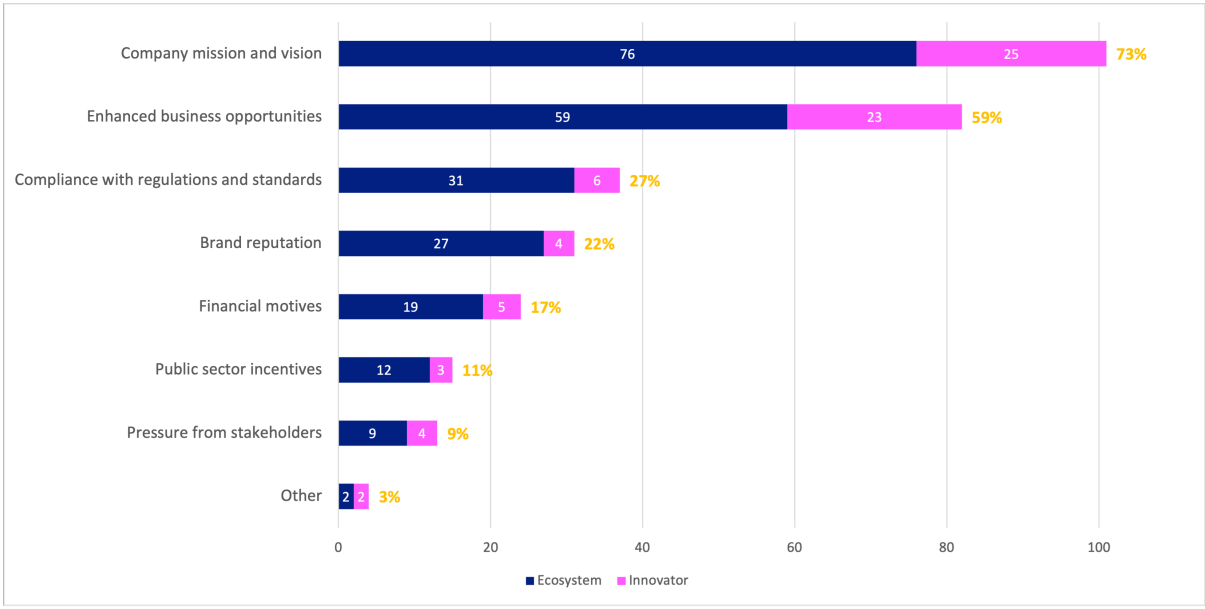

Figure 4.6: Question 2: What are the main drivers for your company to operate in the cleantech sector? (from 1 to 3 choices) - answers [own elaboration]

Question 3

The third question allows companies to choose up to three primary difficulties faced after entering the cleantech sector.

Figure 4.7 illustrates that the option "inadequate intellectual property regimes" was chosen by only three companies in the ecosystem and one innovator: this suggests that the European intellectual property protection system is very robust and reliable, and does not appear to place limits on companies' willingness to invest in R&D.

The remaining votes were distributed among the various options, none of which emerged as a "universal plague". In general, the three most common challenges are: the severity or uncertainty of standards and regulations (47 percent), complexity of developing the technology (36 percent), and limited access to external funding (36 percent). It can also be seen that from the perspective of innovators the complexity of developing technologies is reasonably more relevant (in percentage terms) than for companies in the ecosystem. Apparently there is not much concern for the sustainability of their suppliers, but this issue can be explored in the specific section dedicated to the fourth pillar (resilient supply chain).

Additionally, ten users selected the "Other" option and highlighted various problems. These encompassed barriers to entry or lack of collaboration ("Existing players not open to share with newcomers", "Not fair competition from third countries", "Slow maturing of customer adaptation", "Lack of knowledge about possibilities of high-performance process technologies"); resource challenges ("Supply chain bottlenecks" and "Shortage of internal funds",) and external factors impacting operations like "COVID and energy crisis", "Permits from authorities take too long, averaging 5 years", "Complex and bureaucratic decision-making processes in CO_2 polluting industrial companies" and "Inadequate legal framework".

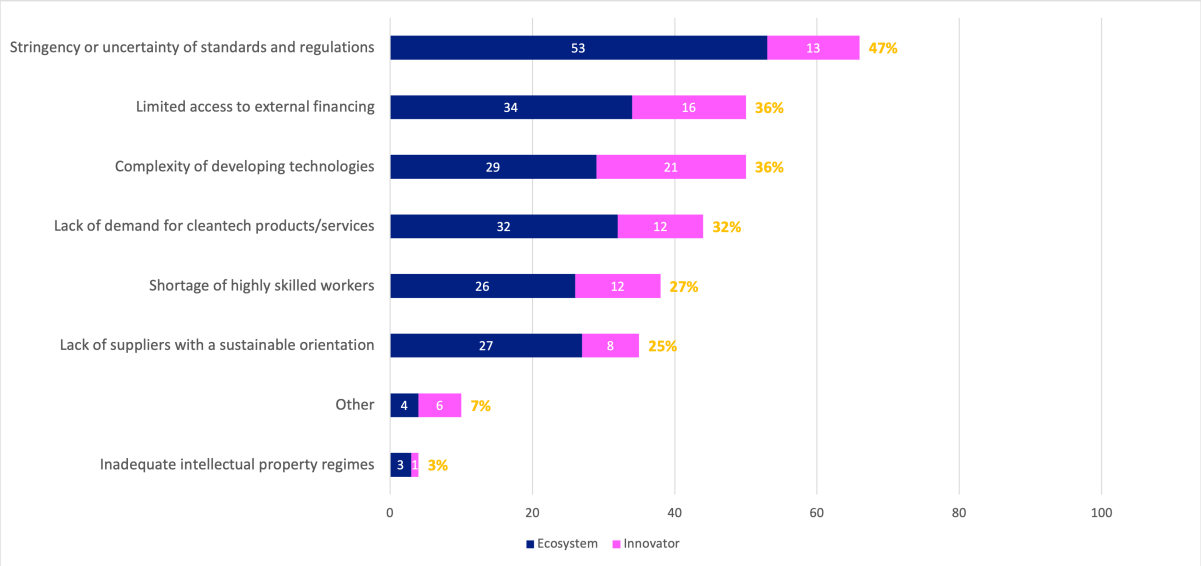

Figure 4.7: Question 3: What are the main difficulties your company faced after you entered the cleantech sector? (from 1 to 3 choices) - answers [own elaboration]

Question 4

The fourth question inquires about the types of uncertainty companies face and the intensity of such uncertainties.

The Figure 4.8 reports that only a small percentage of companies (6 percent) do not experience regulatory uncertainty and slightly more (7 percent) do not encounter market uncertainty. By conducting a modal analysis, it was possible to notice that, for those companies that do face these types of uncertainty, they tend to have a significant impact on their business. Conversely, technological uncertainty is more common, but it typically has a lesser impact on the business. Above all, the incertitude of regulations proved to be a very recurring issue in both the literature review and the analysis of the various applications. The market uncertainty was largely predictable, considering that cleantech is an emerging sector, and one with an as-yet undefined scope.

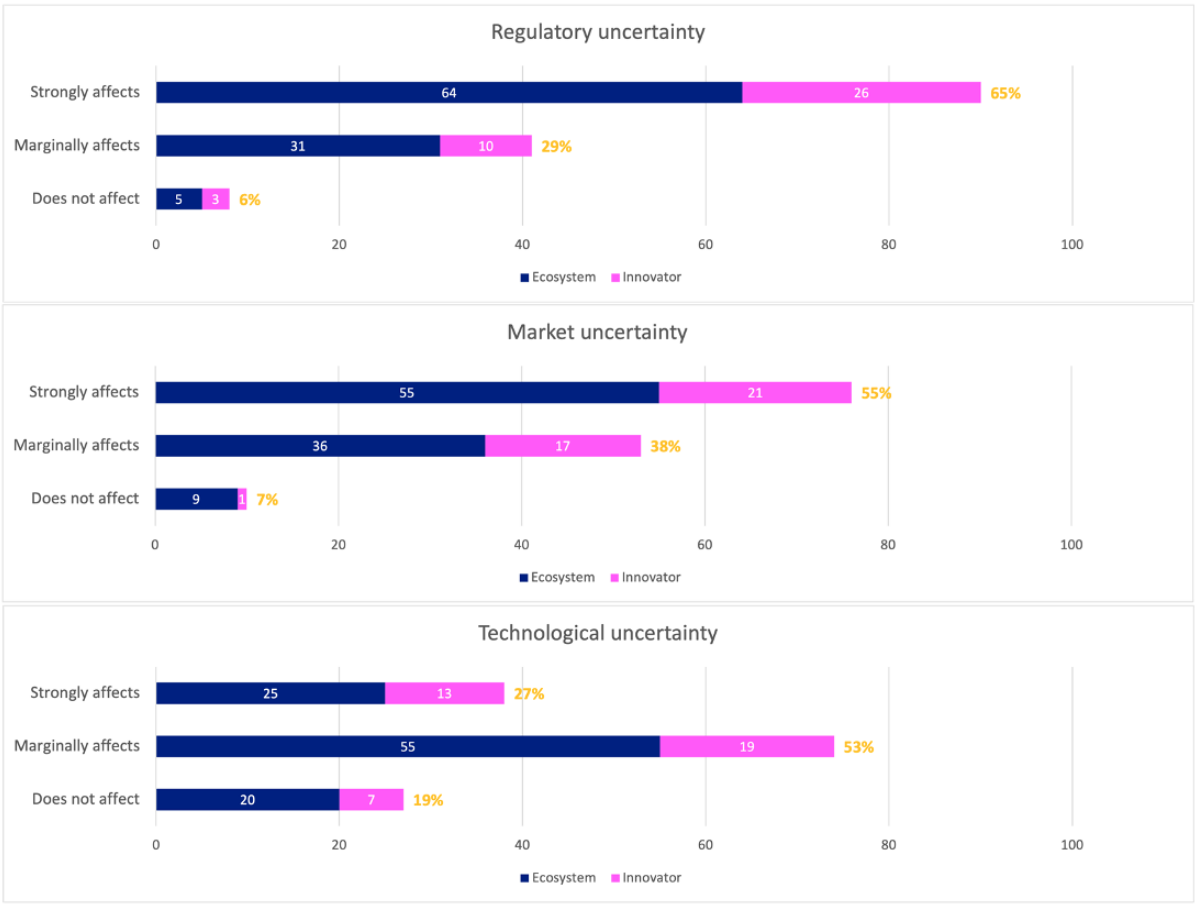

Figure 4.8: Question 4: How much the following types of uncertainty are affecting your activities? (1 choice for each row) - answers [own elaboration]

Question 5

Question 5 has been introduced to gain a better understanding of the extent to which cleantech companies are progressing toward the objectives of the EGD. Specifically, this question allows respondents to select up to three primary actions taken to advance toward a greener future.

This answer is susceptible to desirability bias, but we can immediately see consistencies with the answers already given. For example, 73 percent of the companies in question 1 stated that they entered the cleantech sector because being clean is part of the company DNA. This figure is quite consistent with the fact that, in response to this question, 73 percent of the companies answered that they are directly involved in the development of green products.

Most of companies offers green products or services, while 65 percent uses green technologies. In Figure 4.9, among the solutions most frequently adopted by companies to become more environmentally friendly emerge also using sustainable suppliers and procurement policies (42 percent) and offsetting carbon emissions (24 percent). Fewer than 25 percent of companies engage in upskilling their workforce or encourage remote work, but this figure will need to be compared with the responses to question 16, on skills, to relate it to the actual need for companies to participate in such initiatives. Additional actions that some companies have implemented (and listed under "Other") include efficient production methods such as "new technologies for drying and firing products" and "resource recovery".

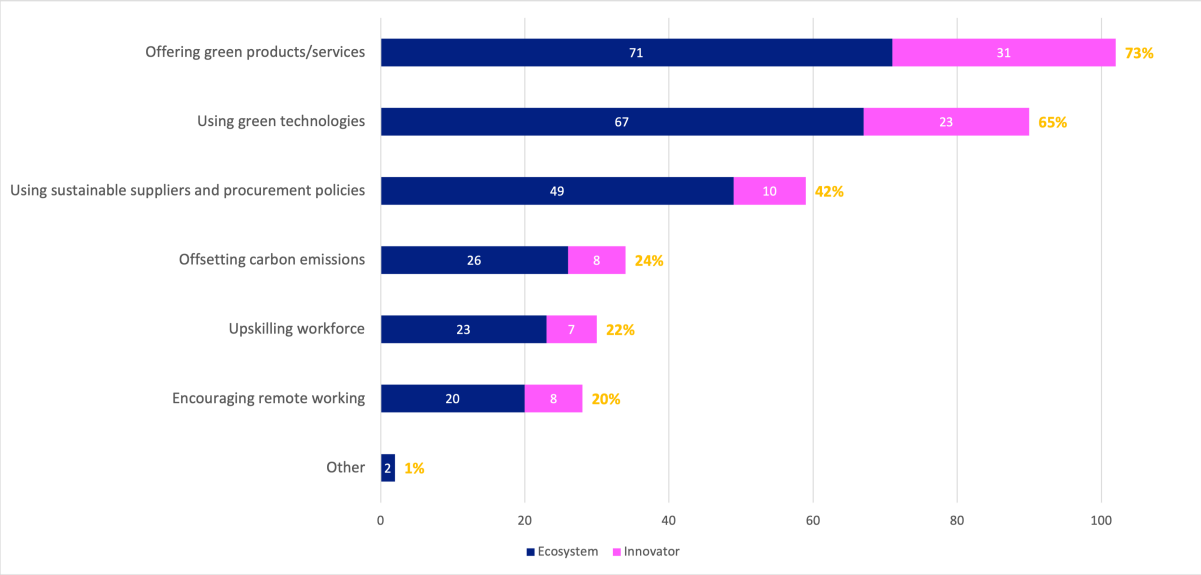

Figure 4.9: Question 5: What is your company doing to meet the goals set by the European Green Deal? (from 1 to 3 choices) - answers [own elaboration]

Question 6

Question 6 initiates a brief section on clean innovation, which also includes questions 7 and 8. Specifically, this question inquires about the Technology Readiness Level (TRL) of the core clean technology integrated into the company's primary project. The Technology Readiness Level (TRL) nine steps scale is a method used to assess the maturity of a technology, from its inception to its practical application. It initiates at TRL 1, where basic principles are observed, progresses through the formulation of a technology concept at TRL 2, and marks the stage when experimental proof of concept is achieved at TRL 3. TRL 4 signifies the validation of the technology in a laboratory setting. Subsequently, TRL 5 involves the validation of the technology in a relevant environment, while TRL 6 demonstrates the technology's capabilities within this environment. TRL 7 involves the demonstration of a system prototype in an operational environment. TRL 8 indicates that the technology is complete and qualified for its intended use, and TRL 9 signifies the technology's proven effectiveness in an operational environment, indicating its readiness for practical implementation.

Anticipated outcomes include elevated TRL values for the ecosystem and reduced TRL values for innovators. This divergence arises because ecosystems are typically positioned at a more advanced stage in the supply chain. Their primary involvement lies in the commercialization or application of technology, rather than direct engagement in its development.

In Figure 4.10, it's worth noting that 2 innovators responded that they do not develop any technology, which appears to be an anomaly. On the other hand, the fact that 21 companies within the ecosystem do not develop clean technologies is not a cause for concern, as this category includes experimenters and manufacturers, but also distributors, integrators and operators.

Both innovators and companies in the ecosystem are engaged in clean technologies that are still under development: it should be mentioned that the EU is home to one-third of the world's top-rated research institutes, one-third of the world's patents, and more climate startups than the United States and China combined. In the majority of instances, the foundational technology exceeds TRL6, indicating its advancement to testing in progressively larger environments. TRL9 is the prevailing level, indicating that

the technology is prepared for integration into a product.

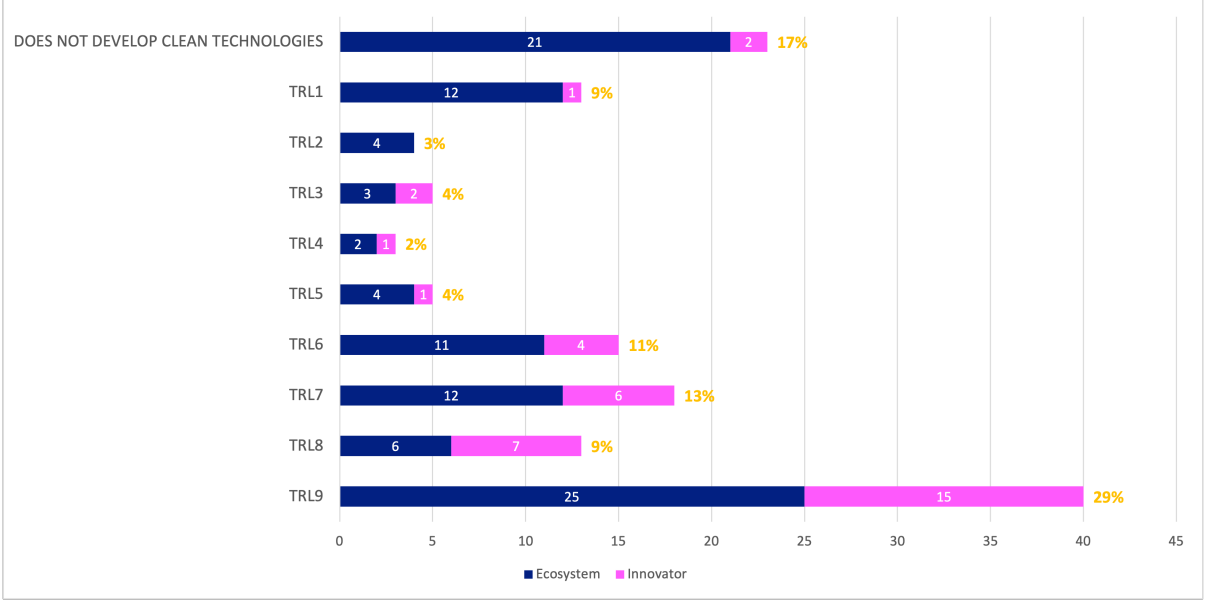

Figure 4.10: Question 6: How would you define the readiness level of the CORE CLEAN TECHNOLOGY embedded in the company's main project (TRL) ? (1 choice) - answers [own elaboration]

The next two questions, 7 and 8, were exclusively given to the 116 respondents who did not choose option "MY COMPANY DOES NOT DEVELOP CLEAN TECHNOLOGIES" in question 6.

Question 7

Question 7 aims to identify the methods companies use for developing innovative technologies.

All methods are widely used. Companies slightly prefer to conduct R&D internally (84 percentage) or engage in joint R&D projects (79 percentage). Receiving support from universities and research centres (75 percentage) and consultancy firms (72 percentage) are also similarly popular choices. Instead, only 60 percentage, opt for Industrial partnerships and/or M&As. Mergers and acquisitions (M&A) and partnerships are infrequently chosen solutions, which aligns logically with the size of the companies under consideration. Small and medium-sized enterprises often lack the resources for elaborate M&A or partnerships, rendering these alternatives less favored. Additionally, from a strategic standpoint, these decisions are intricate, with repercussions over an extended period. Procrastination might occur due to market and regulatory uncertainties, as indicated in the preceding questions.

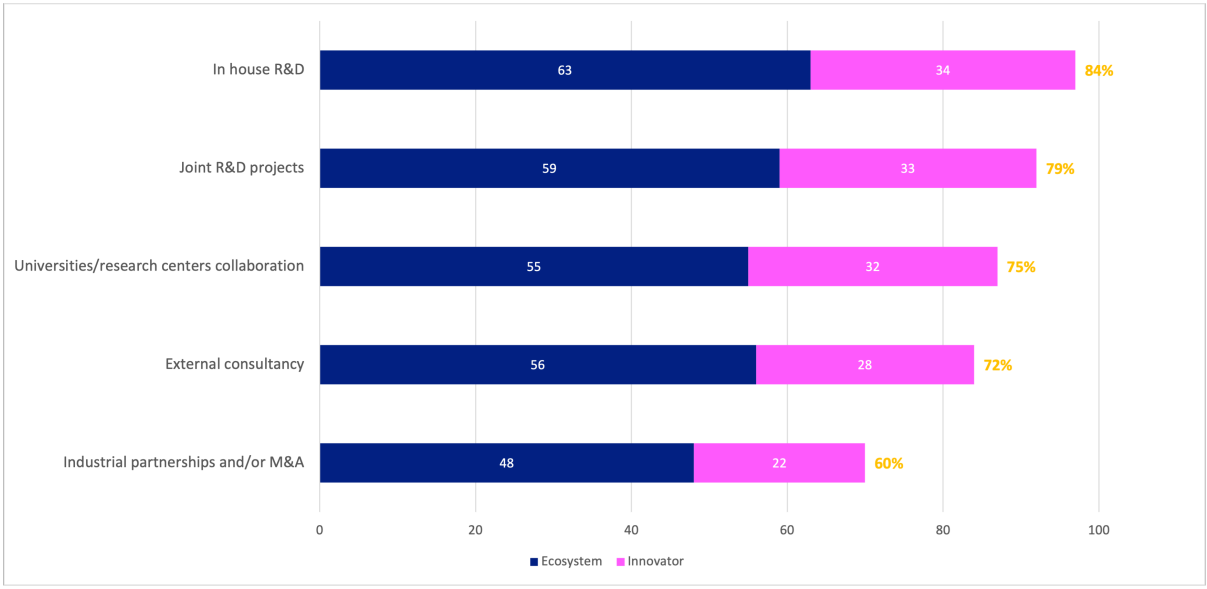

Figure 4.11: Question 7: Referring to your cleantech products or services recent innovations, has your company recently engaged in the following innovation activities? (1 choice for each row) - answers [own elaboration]

Question 8

Question 8 seeks to determine the methods that companies prefer for protecting the results of their research and development activities.

Overall, the widespread adoption of various forms of intellectual property (IP) protection highlights the innovation prowess of these companies. Despite their small size, the fact that they have deemed it necessary to invest in IP protection, such as patents and trademarks instead of relying solely on trade secrets, underscores their commitment to safeguarding their innovative assets.

Patents (59 percent), trademarks (53 percent), and trade secrets (50 percent) are the most commonly used methods by both categories, followed at a distance by copyrights (30 percent), industrial designs (21 percent) ans utility models (19 percent) (Figure 4.12).

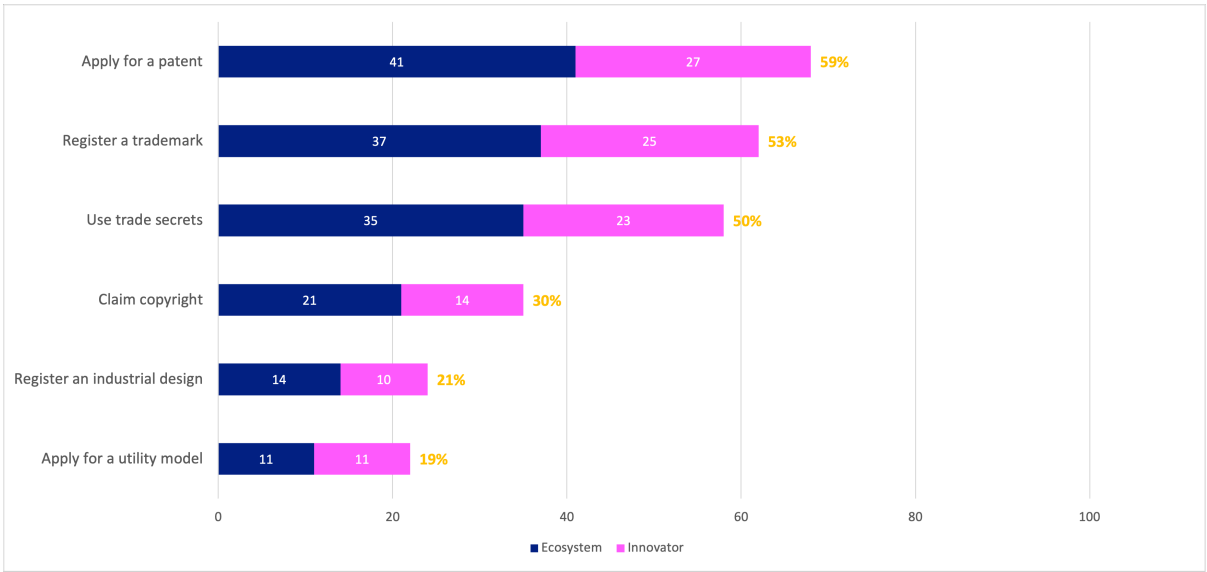

Figure 4.12: Question 8: What has your company done to protect its cleantech intellectual property? (1 choice for each row) - [own elaboration]

Question 9

Question 9 measures how much certain regulations or policies affect cleantech activities. The scale employed is Likert-like and encompasses three levels: ”does not affect”, ”marginally affects”, and ”strongly affects”. Since these three alternatives are organized on an ordinal scale, it enables modal analysis.

For illustrative clarity, a decision was made to segregate the responses of innovators from those of ecosystem companies. This division aims to determine, for each category, which responses are deemed most important. Subsequently, the goal is to explore whether there are similar preferences between the two groups.

For both innovators and companies that are part of the cleantech ecosystem in no case was “does not affect” the predominant answer. All of the listed policies (Figures 4.13, 4.14) influence the surveyed companies in some way, either marginally or strongly. Policies due to the introduction and development of new technologies (perceived by about 95 percent of companies) and environmental policies (perceived by about 91 percent of companies) have the strongest impact according to both types of respondents. The other most influential policies relate to product safety (about 83 percent) and operational and worker safety (80 percent on average).

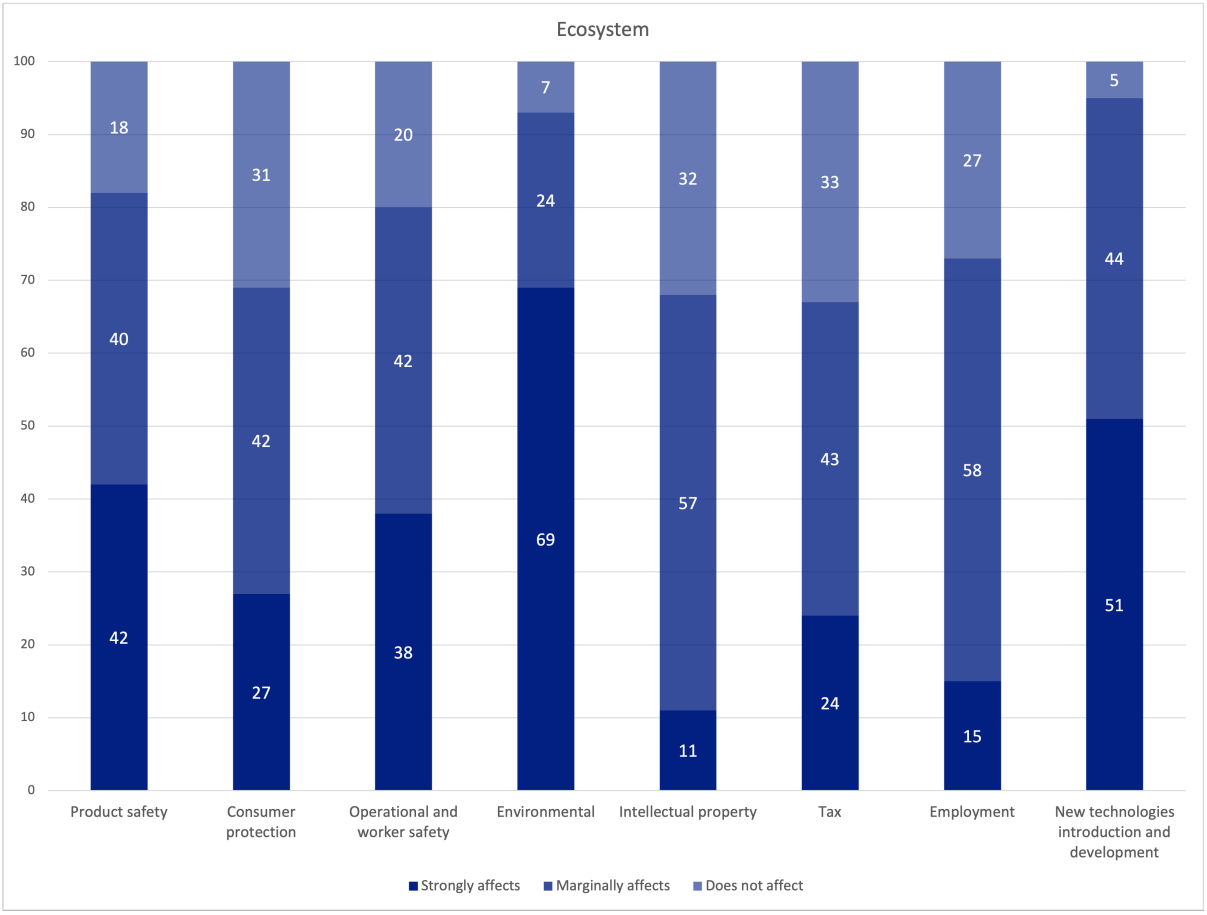

Figure 4.13: Question 9: How much are regulations/policies on the below area affecting your cleantech activities? (1 choice for each row) - Ecosystem's answers [own elaboration]

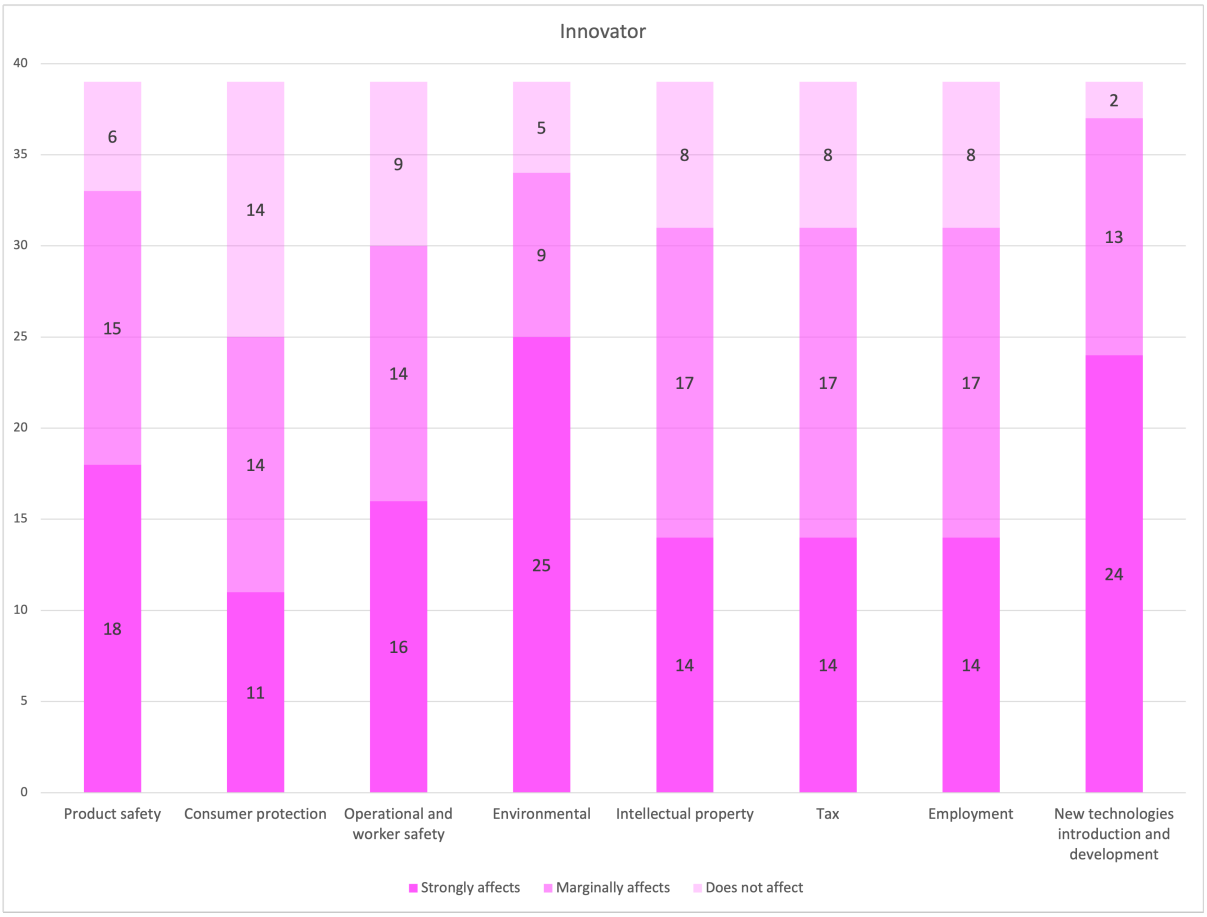

Figure 4.14: Question 9: How much are regulations/policies on the below area affecting your cleantech activities? (1 choice for each row) - Innovators' answers [own elaboration]

Question 10

Question 10 aims to identify what are the main negative effects of regulations or policies, giving voice to one of the most highlighted themes during the last Cleatech for Europe Summit, which indicated that regulations pose a threat to the European innovation ecosystem.

Most companies are somehow negatively affected by policies and regulations (Figure 4.15), as only 14 percent declared that there are not undesirable effects of recent regulations and policies on their cleantech activities. This is typically due to excessive administrative burden (58 percent) and operational uncertainty (47 percent). More rarely, respondents report challenges related to unbalanced competition with non-EU companies (32 percent) and obstruction of innovation (19 percent). Additionally, 7 percent prefer a more accurate description of their situation, generally complaining that they do not receive enough support from policy makers.

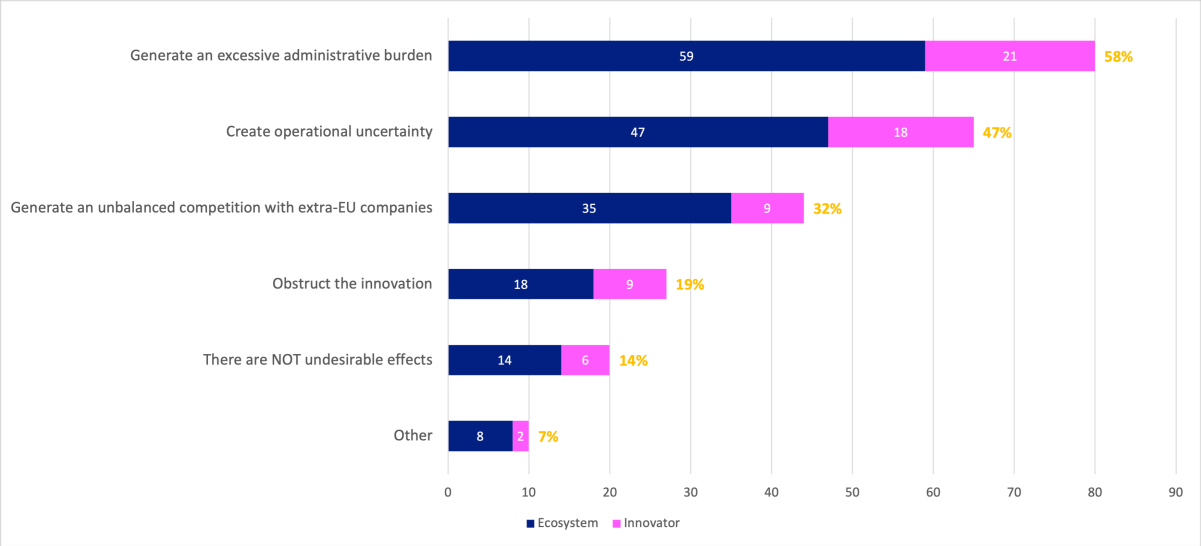

Figure 4.15: Question 10: What are the undesirable effects of recent regulations/policies on your cleantech activities? (from 1 to 3 choices) - answers [own elaboration]

While the first two adverse effects are foreseeable and have already been addressed in the literature, the others raise concerns. Specifically, there is a pressing need to ensure that overly stringent regulations do not impede innovation by compelling companies to relocate their operations or supply chains. This could exacerbate a trend previously explored in the literature: the relocation of companies to the United States to take advantage of more robust financial support.

Question 11

Question 11 seeks suggestions for future policies and regulations that can better support technology development in the cleantech sector.

In this instance, for the first time, the responses of innovators and ecosystem companies exhibit a slight divergence. While acknowledging that a more substantial number of responses would enhance the significance of this analysis, the result aligns with the notion that the two types of companies fulfill distinct functions within the cleantech supply chain. Consequently, it is reasonable to expect that they would require different forms of support from governments.

From Figure 4.16 emerges that companies emphasize tax incentives (55 percent), direct policies (55 percent), and new regulations and standardization (42 percent) as most effective. The other solutions did not capture the interest of companies very much. Especially boosting outcomes, dialogue & networking and developing complementary assets would be of little use from their point of view.

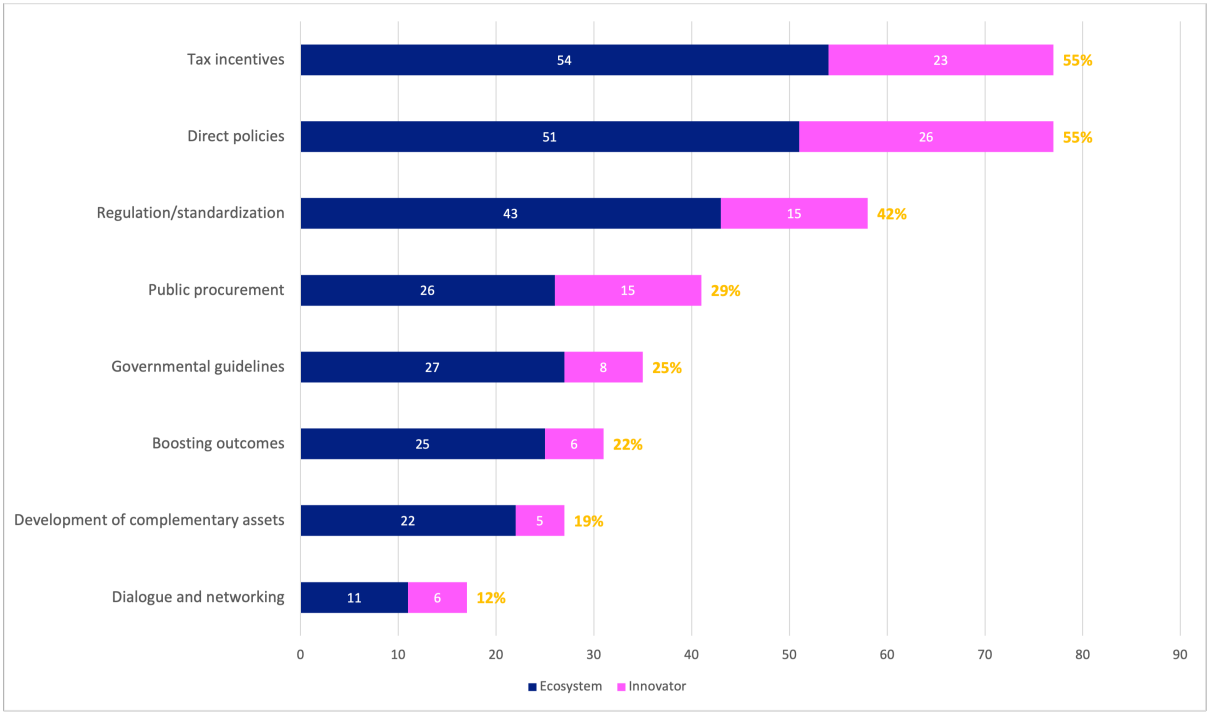

Figure 4.16: Question 11: Which of these regulations/policies can mostly support technological development in the cleantech sector? (from 1 to 3 choices) - answers [own elaboration]

Question 12

This last question in the section on regulation seeks to collect companies' opinions on the policies and regulations that have been put in place in the recent past. The questions are designed to have a positive connotation: this avoids confusing and stressing the respondent.

Overall, companies find the objectives and measures of the Green Deal transparent and clear. Unfortunately, with regard to the other statements, it can be seen that most companies preferred not to take a stance, favouring option "Neither agree or disagree" and avoiding the extremes of the Likert scale (Figure 4.17). This question will be further analysed by geography at the end of this chapter.

Figure 4.17: Question 12: Referring to the main regulations/policies relevant to your core cleantech activities, how much do you agree on the following statements? (1 choice for each row) - answers [own elaboration]

Question 13

Question 13 is structured in three steps. Firstly, the companies that intend to raise funds in the future are selected. About half of the companies intend to acquire external funds. In particular, 43 are ecosystem companies, and 23 are innovators (Figure 4.18). Examining these figures in percentage terms reveals that innovators express a greater need for financing compared to companies in the ecosystem. Specifically, over 50 percent of innovators responded with ”yes,” while the corresponding percentage for companies in the ecosystem is 40 percent.

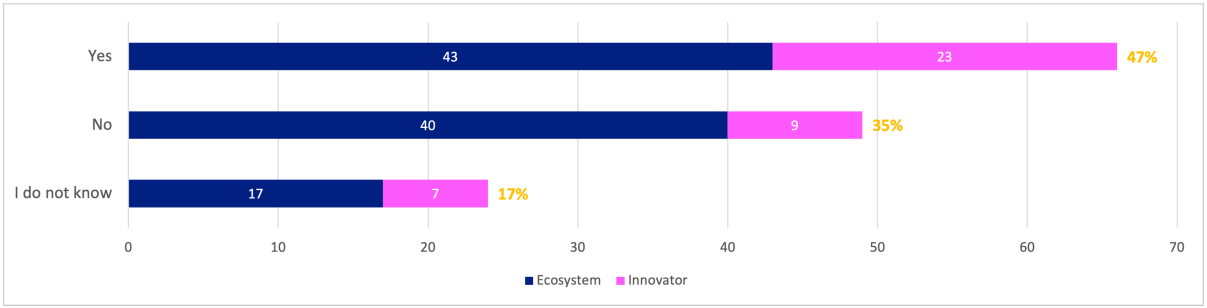

Figure 4.18: Question 13a: Does your company have any plans to raise funds from EXTERNAL investors for its ongoing activities? (1 choice) - answers [own elaboration]

These 66 companies, despite being SMEs, typically require funding in the range of millions of euros. Even one third of the respondents require over 50 million euros to meet their financial needs (Figure 4.19). On the contrary, only one would need less than 500k euros.

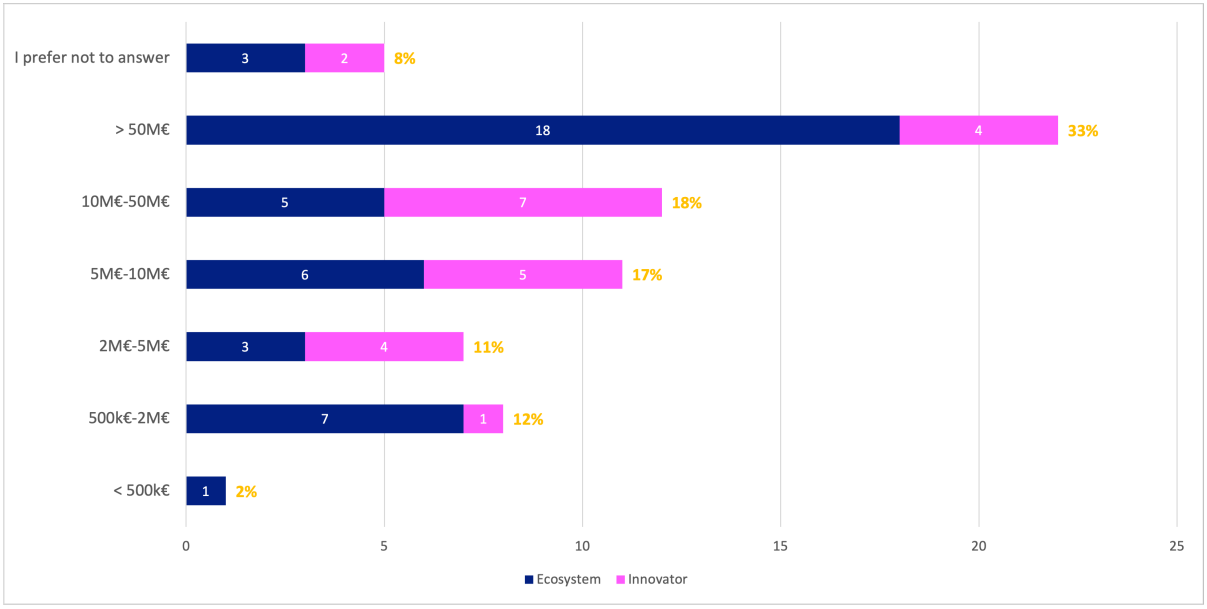

Figure 4.19: Question 13b: How much do you want to raise for your activities in the next five years? (1 choice) - answers [own elaboration]

Most of these 66 companies (71 percent) intend to dedicate a large part of the raised funds to cleantech activities. Conversely, only 3 percent of companies intend to devote to clean innovation less than 25 percent.

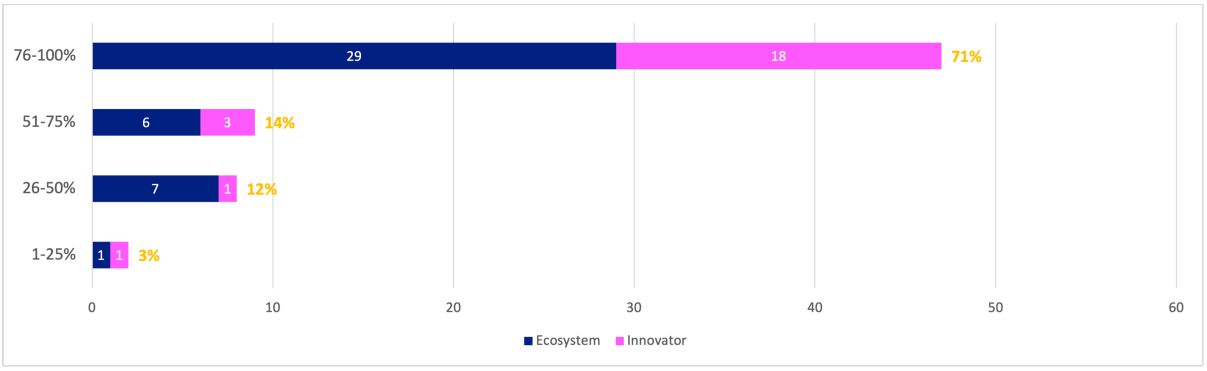

Figure 4.20: Question 13c: How much of the funding you intend to raise will be dedicated to support cleantech activities? (1 choice) - answers [own elaboration]

Question 14

Focusing on public funding programmes, question 14 asks what are the main challenges in participating in them.

Only 5 percent of the companies have never encountered difficulties in accessing public funds. The majority of companies (63 percent) find the application process time-consuming and complex and 14 percent believe that there is high competition when accessing public funds or lack of awareness of their

existence (Figure 4.21). This figure is consistent with the evidence gathered during the Cleantech for Europe Summit.

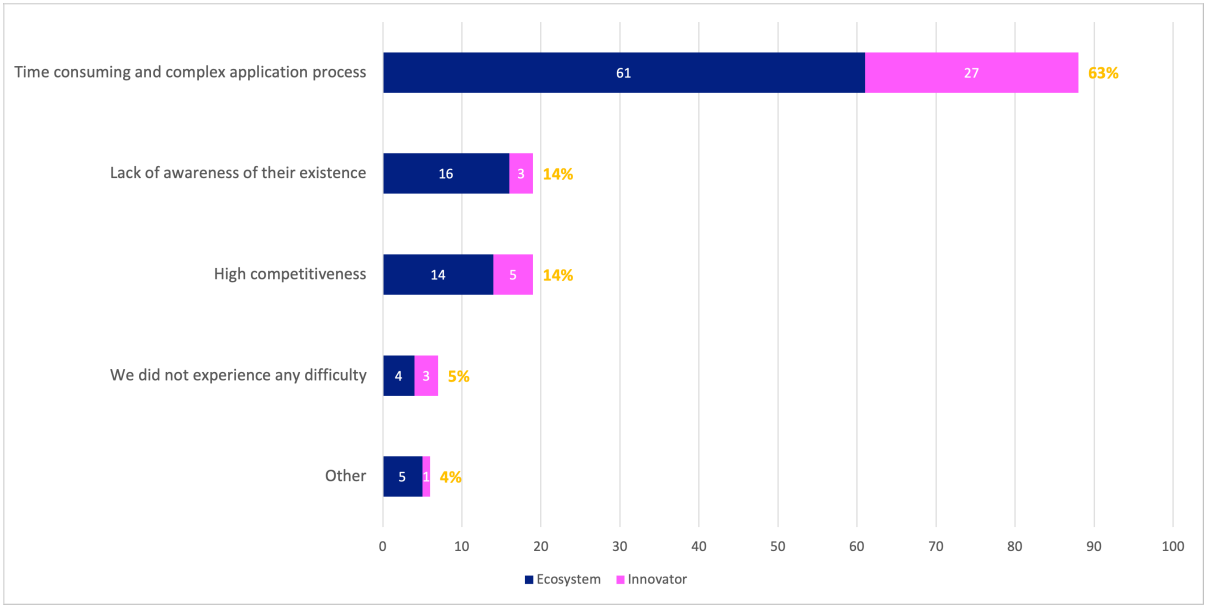

Figure 4.21: Question 14: What is the main challenge in participating in public funding programmes? (1 choice) - answers [own elaboration]

Question 15

Question 15 collects companies' opinions on the main methods of financing.

For illustrative clarity, it was chosen to separate the responses of innovators from those of ecosystem companies in order to define, for both categories, the preferred financial instruments and then assess whether there are similar preferences. In the past, ecosystem companies have relied extensively on bank debt. Innovators, on the other hand, have also used equity and grant funding extensively. However, for both categories, the most common option has been internal financing. In the future, ESG/green bonds and hybrid financing instruments are being considered. In the past, no companies in the ecosystem and only 4 innovators have used alternative online financing, and many said they would never use it in the future (Figures 4.22 and 4.23).

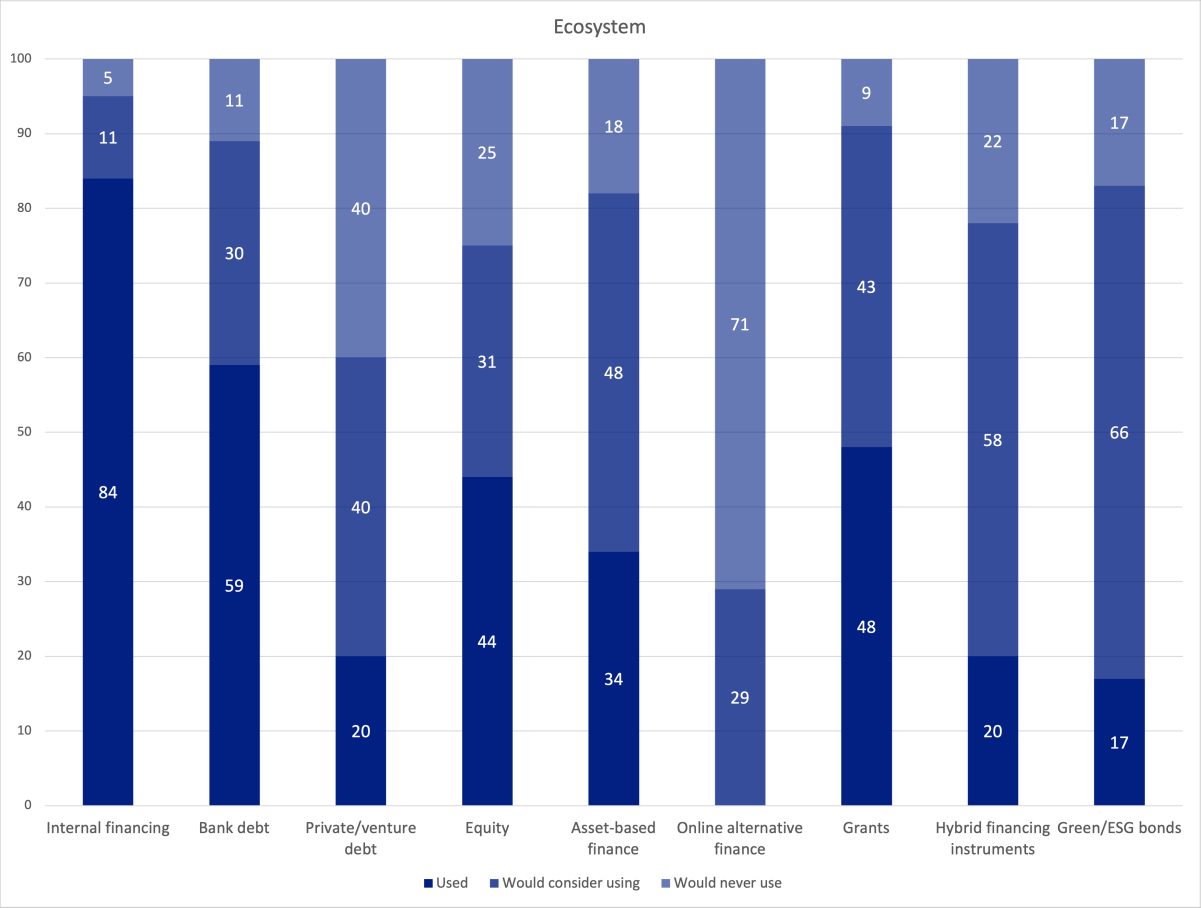

Figure 4.22: Question 15: Has your company used or would consider using the following financing instruments? (1 choice for each row) - Ecosystem's answers [own elaboration]

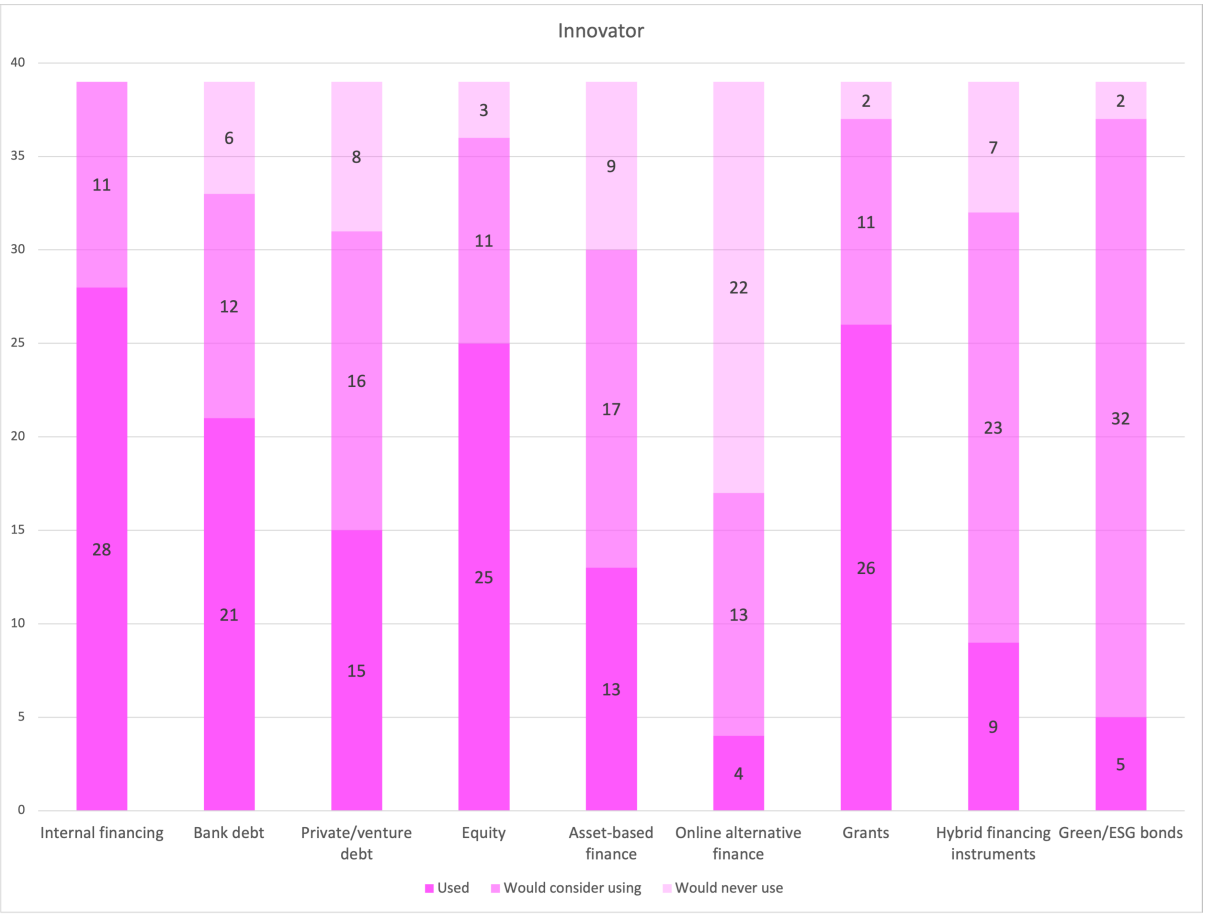

Figure 4.23: Question 15: Has your company used or would consider using the following financing instruments? (1 choice for each row) - Innovator's answers [own elaboration]

The ease of access to finance is typically correlated with firm size. Consequently, the lack of capital poses a significant challenge for Europe's 25 million SMEs, which represent over 99 percent of businesses in the EU [112]. Smaller businesses are particularly exposed to downturns in the supply of finance due to their higher risk profile and commonly limited collateral options. **Access to finance is a significant hindrance, especially for young and fast-growing SMEs** [113]. The EIBURS reserch team, in its first working paper published for EIF, dedicated a section to the study of Cleantech financing. It highlighted that the class of companies with the highest share of VC-backed firms is dedicated to sustainable energy production or involved in the energy- efficiency industry. VC investors also recognize the importance of solutions addressing environmental pollution and waste management challenges. Notably, 63.7 percent of the patenting companies that received VC investments have obtained at least one EPO patent specifically in the CCMT (Clean and Climate-friendly Mobile Technologies) fields.

Question 16

Question 16 is the one dedicated to the skills shortages plaguing Europe's cleantech companies.

For illustrative clarity, it was chosen to separate the responses of innovators from those of ecosystem companies (Figures 4.24 and 4.25) to define the preferences of both categories and then assess whether there are similar ones.

For both innovators and ecosystem companies, many of the necessary skills are already available (in

blue), or companies have found ways to develop them internally (in green). The yellow bar represents the number of companies for which a certain skill is not useful. Therefore, concerns should be focused on the areas in orange, representing competencies that need to be acquired externally.

In both cases, the orange bars are particularly high for legal and intellectual property management skills. This is reasonable, considering that members of these small and medium-sized firms tend to have technical engineering backgrounds, and the skills in question are not core to the business. Additionally, the orange bar corresponding to R&D skills for ecosystem companies is lower in percentage terms than that of innovators, who naturally engage more intensively in this type of activity.

In percentage terms, innovators currently have a greater need and are more actively seeking skills in sustainability and marketing than ecosystem companies. In contrast, design skills are more sought after by ecosystem companies. Soft skills, technology and engineering skills, finance and accounting skills, and business and strategic planning are not major concerns.

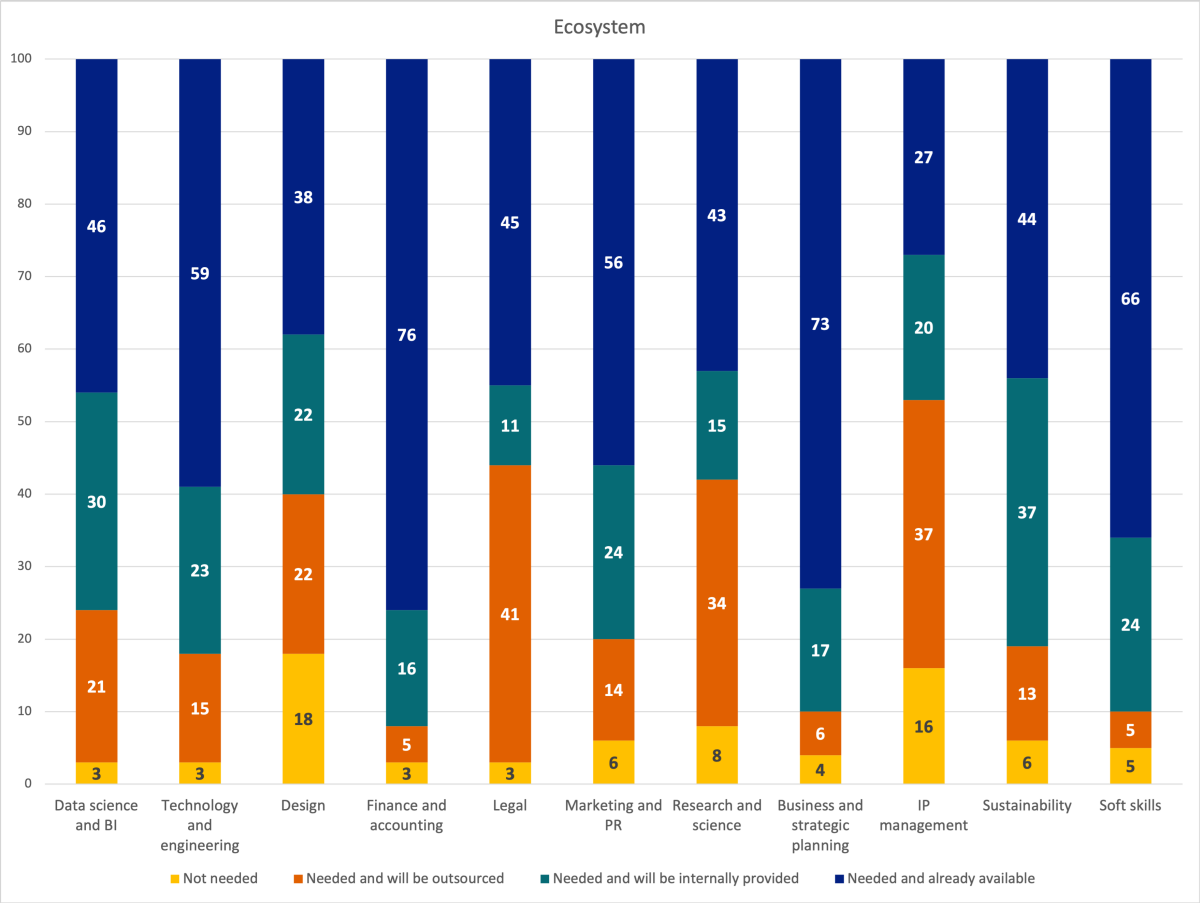

Figure 4.24: Question 16: State if the skills listed are needed in your company and if you are going to outsource them (1 choice for each row) - Ecosystem's answers [own elaboration]

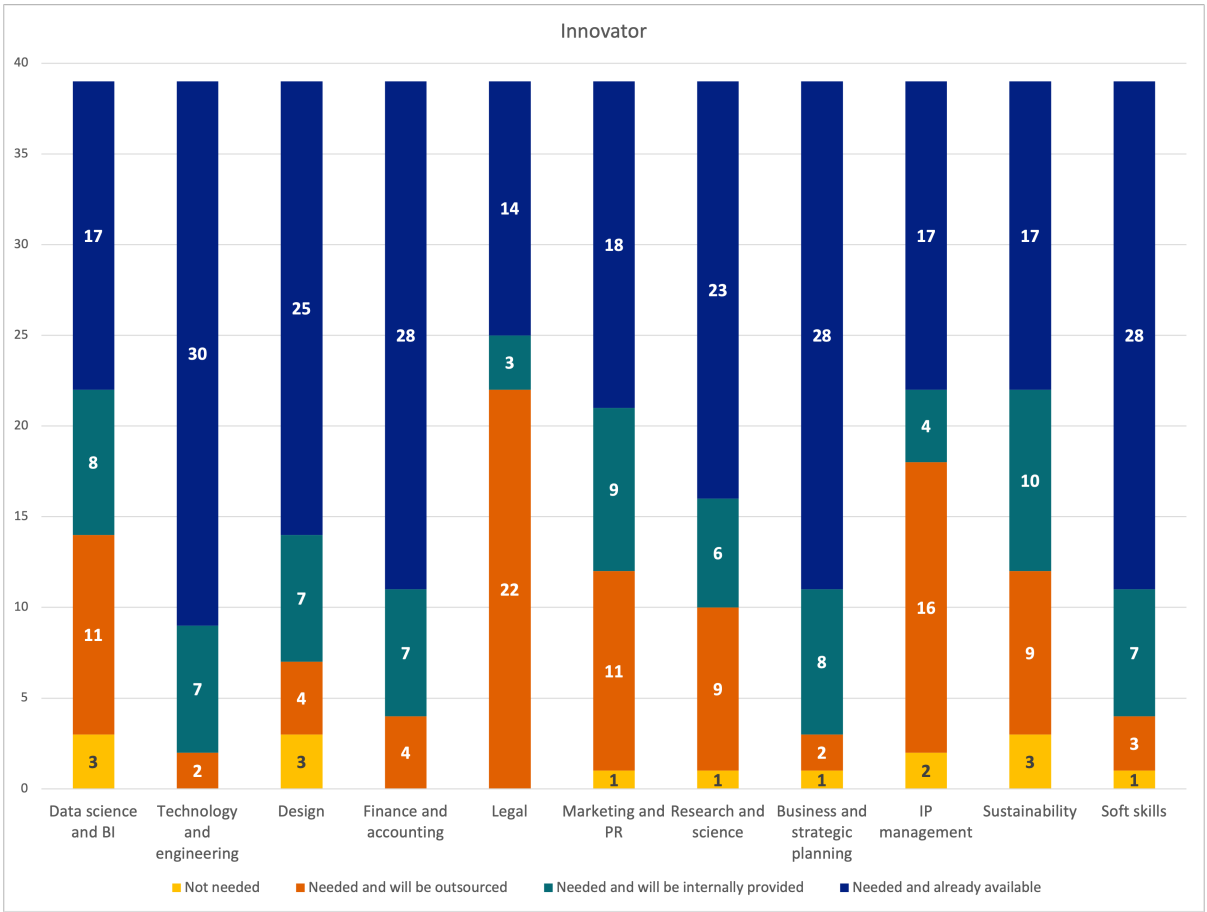

Figure 4.25: Question 16: State if the skills listed are needed in your company and if you are going to outsource them (1 choice for each row) - Innovator's answers [own elaboration]

Question 17

Question 17 opens the section on supply chain resilience, assessing the average supply chain extraction based on the location of most of the suppliers of each company.

Few companies manage to have a local supply chain, even only 2 percent of innovators and 10 percent of ecosystem companies succeed, but most companies (85 percent) manage to have a supply chain limited to European borders.

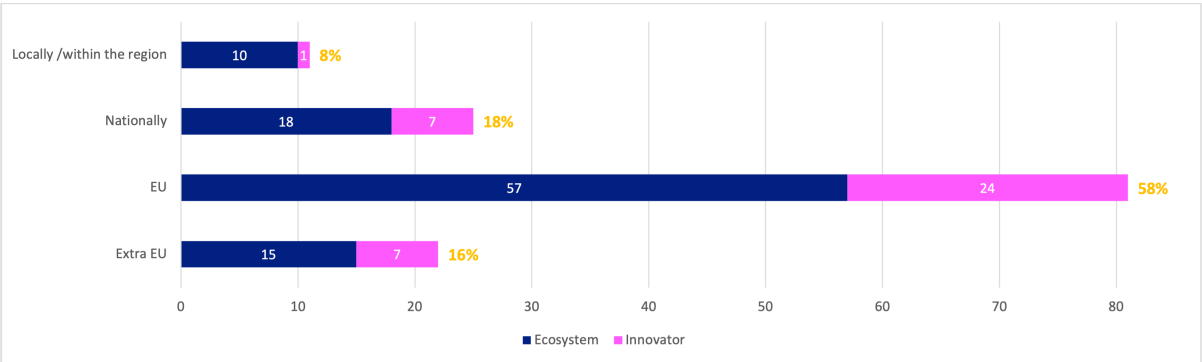

Figure 4.26: Question 17: Where are your suppliers mainly localized? (1 choice) - answers [own elaboration]

Question 18

Question 18 investigates what reasons led to the supply chain structure stated in the previous question.

From Figure 4.27 emerges that quality (70 percent) and price (60 percent) have strongly influenced the choices of companies. Some companies have also declared not to have alternatives, mainly due to the limited availability of raw materials in the EU. Decision-making factors related to sustainability (31 percent) and proximity (24 percent), on the other hand, rank in the middle. The cultural affinity (9 percent) seem to be more negligible factor. Again, no significant differences have been noted in the preferences between innovators and ecosystem companies.

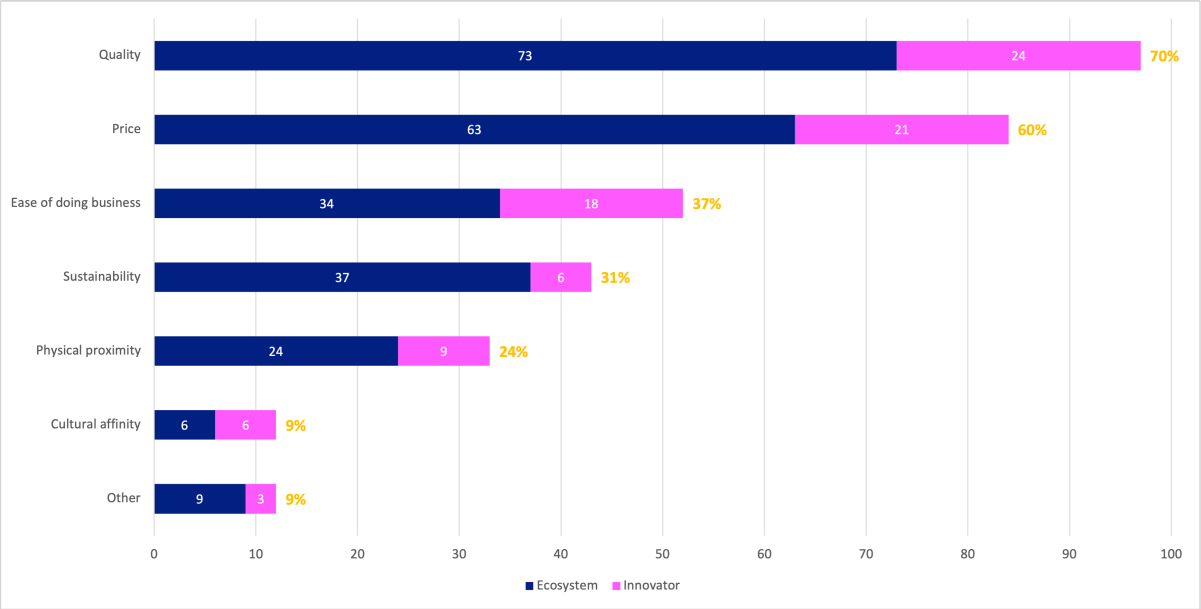

Figure 4.27: Question 18: Which are the main reasons for the selection of the current pool of suppliers? (from 1 to 3 choices) - answers [own elaboration]

Question 19

Question 19 seeks suggestions for future policies that can better support the resilience of supply chains of the country in which the company is located.

According to most respondents, better trade and investment policies (65 percent) and critical infrastructure interventions (48 percent) can help enhance supply chain resilience. Additionally, trade facilitation (23 percent), ensured supply (28 percent) and lower costs (20 percent) of essential goods may also make a smaller contribution.

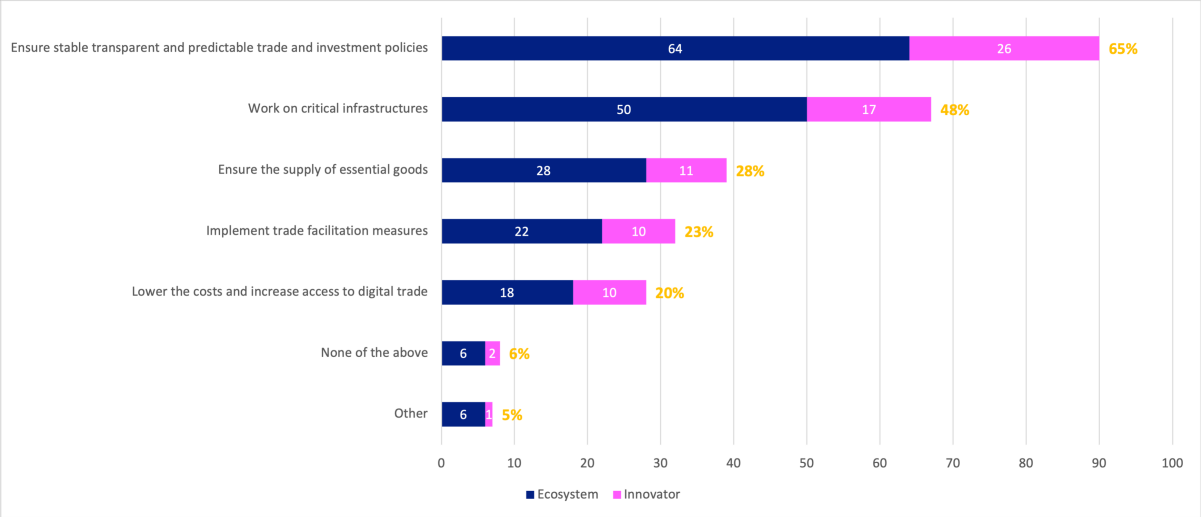

Figure 4.28: Question 19: Which of the following policy goals should the government pursue to improve the resilience of supply chains in your country? (from 1 to 3 choices) - answers [own elaboration]

Question 20

Seeking to understand how companies are personally addressing the issue of supply chain resilience, question 20 investigates what actions they have put in place to this end.

Only 12 percent of the companies did not try any of the proposed initiatives to improve their supply chain resilience. The most implemented actions, according to Figure 4.29, are Selective risk-taking (44 percent) and Hedging (39 percent). Selective risk-taking pertains to intentionally accepting risks in specific areas of the supply chain where it is believed they can be more effectively managed or mitigated. Hedging involves safeguarding against potential financial losses through the acquisition of financial instruments like futures or options, allowing the fixation of prices or exchange rates at a specific level. Following these, in preferred order, are Postponement (27 percent), which entails deferring certain activities or decisions until more information is available or a more opportune time, and Control (24 percent), which involves implementing measures to vigilantly monitor and manage risks within the supply chain. Transferring or sharing risks (18 percent) involves redistributing or dispersing risks to other parties. Security (18 percent) involves ensuring the safety and protection of supply chain operations.

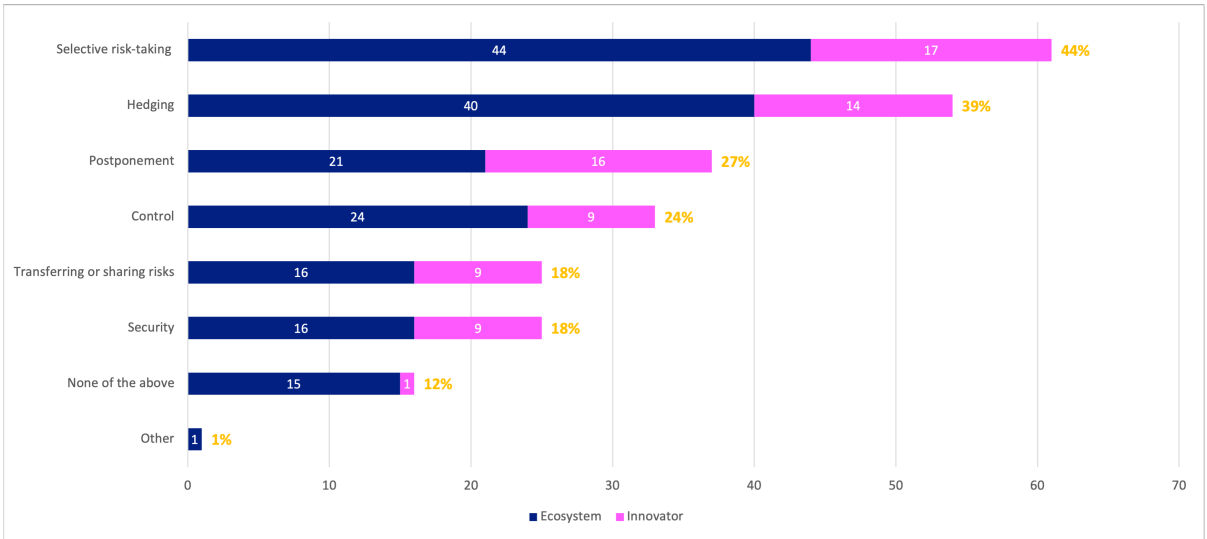

Figure 4.29: Question 20: Which of the following actions is YOUR COMPANY considering to make its supply chain more resilient? (from 1 to 3 choices) - answers [own elaboration]

Question 21

Question 21 is the first to ask for the respondent's personal opinion on EGD. It employs a Likert scale structured around five sub-questions.

Modal analysis (Figure 4.30) illustrates that respondents typically prefer not to take a definitive stance, neither agreeing nor disagreeing.

The issues on which respondents have been more vocal indicate a high perceived risk of poor enforceability of the EGD at the European level. Additionally, 41 percent express concern about the potential creation of greater disparities among different European regions and countries, which could exacerbate differences between countries more and less oriented towards sustainability. Coherently, almost all respondents agree on the challenging coordinating role of various member countries in achieving common objectives. On the other hand, around 50 percent of respondents appear confident that the EGD will create a predictable and clear regulatory environment. However, concerns are raised about the perceived ambition of the goals and the potential challenges in achieving them.

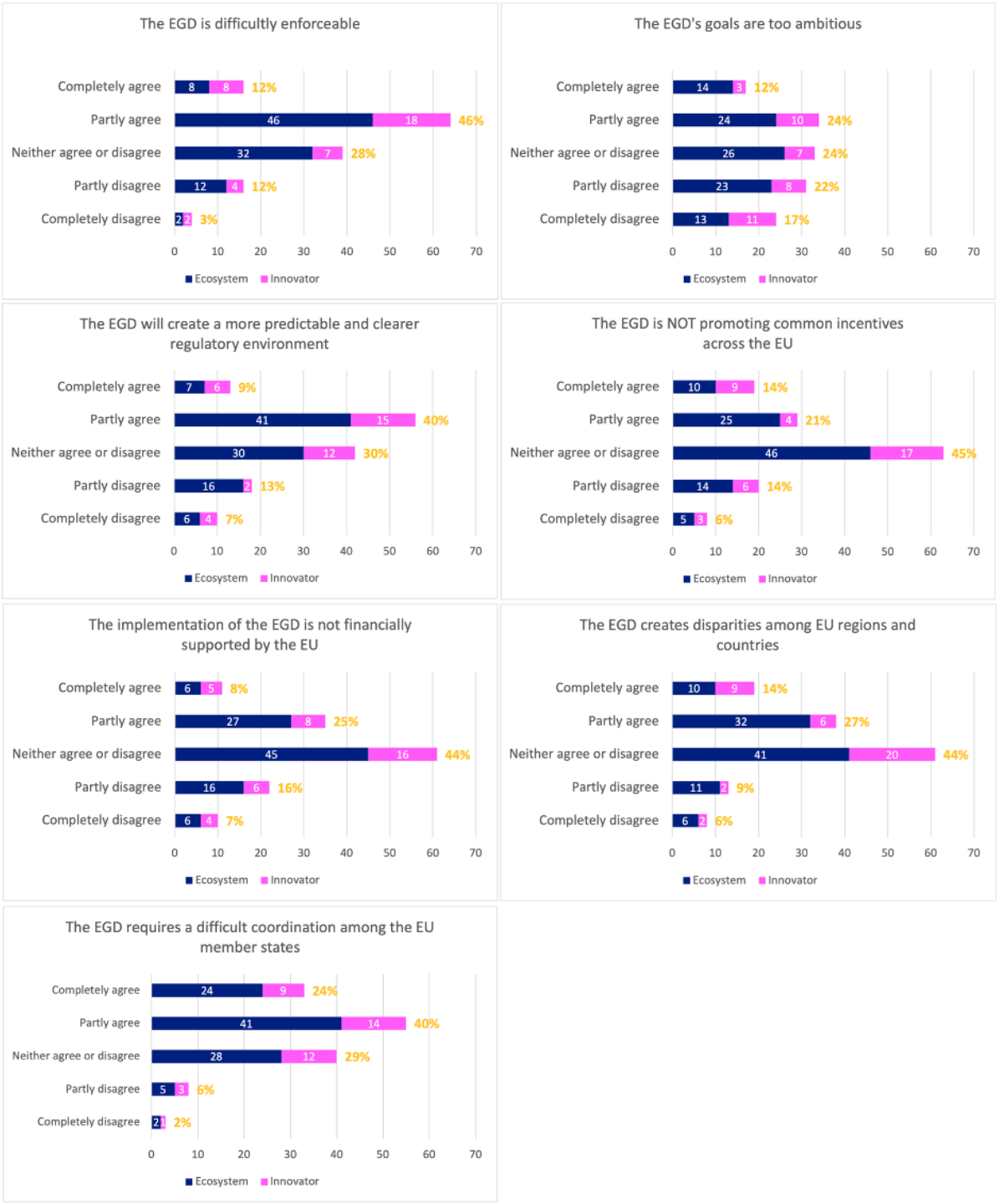

Figure 4.30: Question 21: How much would you agree with the following statements about the EU Green Deal (EGD)? (1 choice for each row) - answers [own elaboration]

Question 22

For question 22, employing a Likert scale, respondents are prompted to share their opinions on achieving net zero by 2050. The question is structured in three stages, progressively encompassing broader geographic areas: first regarding one's own company, then pertaining to one's own country, and finally concerning the European Union.

In general, companies appear confident and optimistic: all three scenarios seem potentially achievable according to modal analysis, leaning towards ”Partially agree” or ”Fully agree”. Notably, the confidence in goal attainment diminishes with the geographical scope: 67 percent express confidence in their company’s capabilities, 50 percent in their nation’s capabilities, and 49 percent in the capabilities of the entire EU.

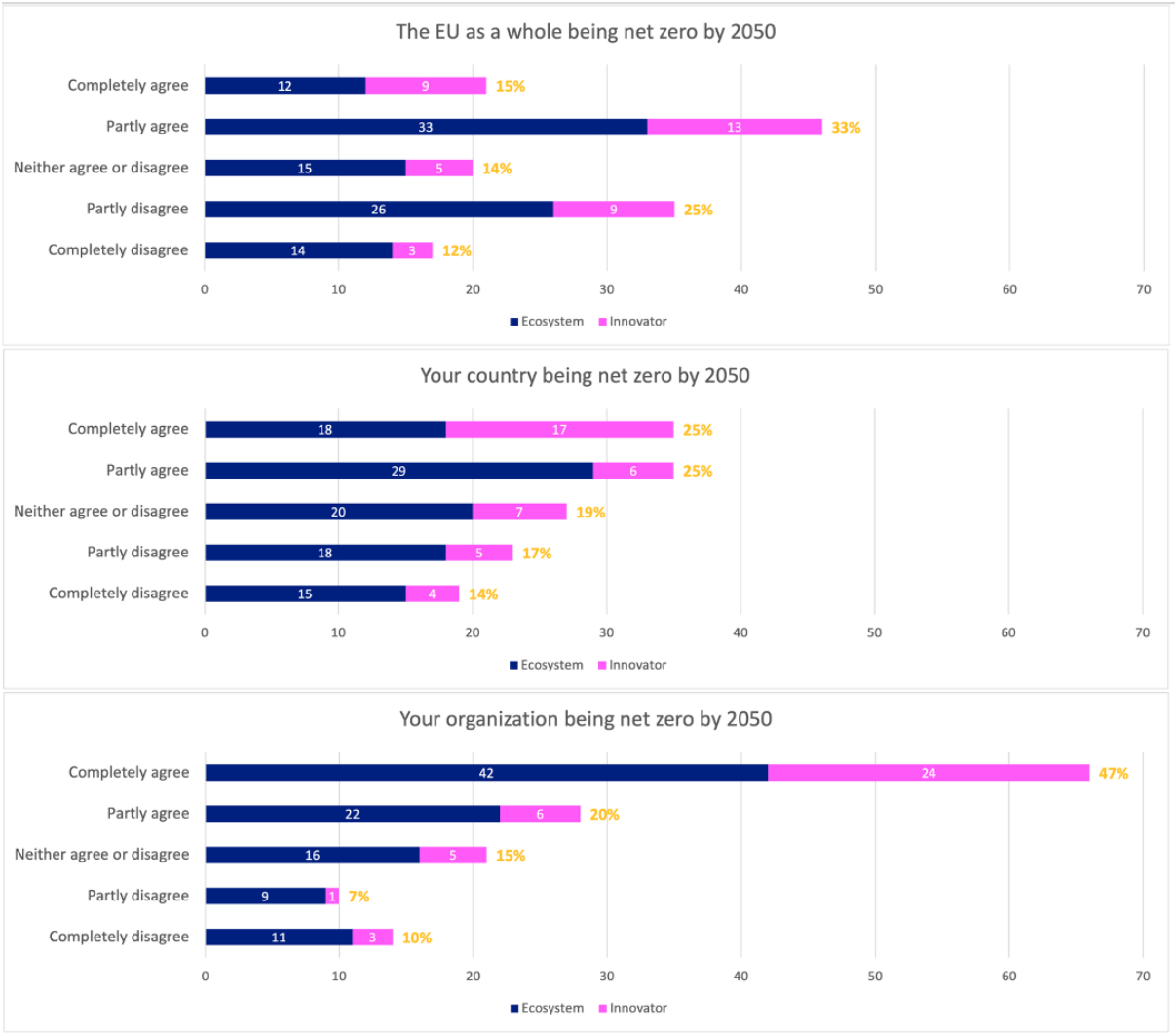

Figure 4.31: Question 22: How achievable do you think are the following scenarios? (1 choice for each row) - answers [own elaboration]

Question 23

The 74 percent of the respondents, equivalent to 125 individuals, expressed a willingness to participate in additional interviews to provide further insights into the cleantech sector. Among them, approximately half hold leadership positions (CEOs), and eight specifically serve as Chief Financial Officers (CFOs). This accomplishment holds significant value, given the considerable challenge of eliciting responses from individuals at such elevated positions within a company’s hierarchy, possessing extensive and profound knowledge of its objectives. The remaining participants are nearly evenly distributed among various roles within their respective organizations: those dealing with corporate sustainability issues, individuals involved in marketing and investor communications, personnel from the sales and

finance branches, and those with technical roles or engagement in project management.

The information suggests a diverse range of perspectives, as participants represent various facets of companies, including sustainability, marketing, finance, and technical expertise.

Questions 24-26

The responses to questions 24, 25, and 26, which contain personal data, will not be provided due to privacy considerations.

4.2.1 Clusterization

At present, the available data does not facilitate the execution of a thorough cluster analysis. Nevertheless, the objective of this chapter is to showcase that the survey structure has been meticulously designed. In the event of higher response rates, it would be possible to conduct the analysis of various questions through clustering based on factors such as nation, geographical area, sector, year of incorporation, and number of employees. Furthermore, this survey comprehensively addresses all areas of action within the Green Deal, with questions strategically formulated to enable correlation. This approach enables the estimation of the diverse impacts that a specific political initiative could potentially yield.

Clusterization by geography

A possible initial application of cluster analysis allows us to demonstrate how the perception of the ultimate goal of the Green Deal, the drastic reduction of CO_2 equivalents emissions until their nullification, varies among different European geographical areas.

Eastern and Mediterranean countries stand out as particularly skeptical about achieving the ambitious Net Zero goal by 2050, irrespective of the geographical scale under consideration. Conversely, the United Kingdom and Nordic countries exhibit a notably optimistic outlook. Companies situated in the Balkans or within Central Europe appear to exude greater confidence in their capacities compared to both individual nations and the broader European context. This regional optimism underscores a nuanced perspective within Europe's diverse landscape, highlighting varying degrees of confidence in the pursuit of sustainability goals.

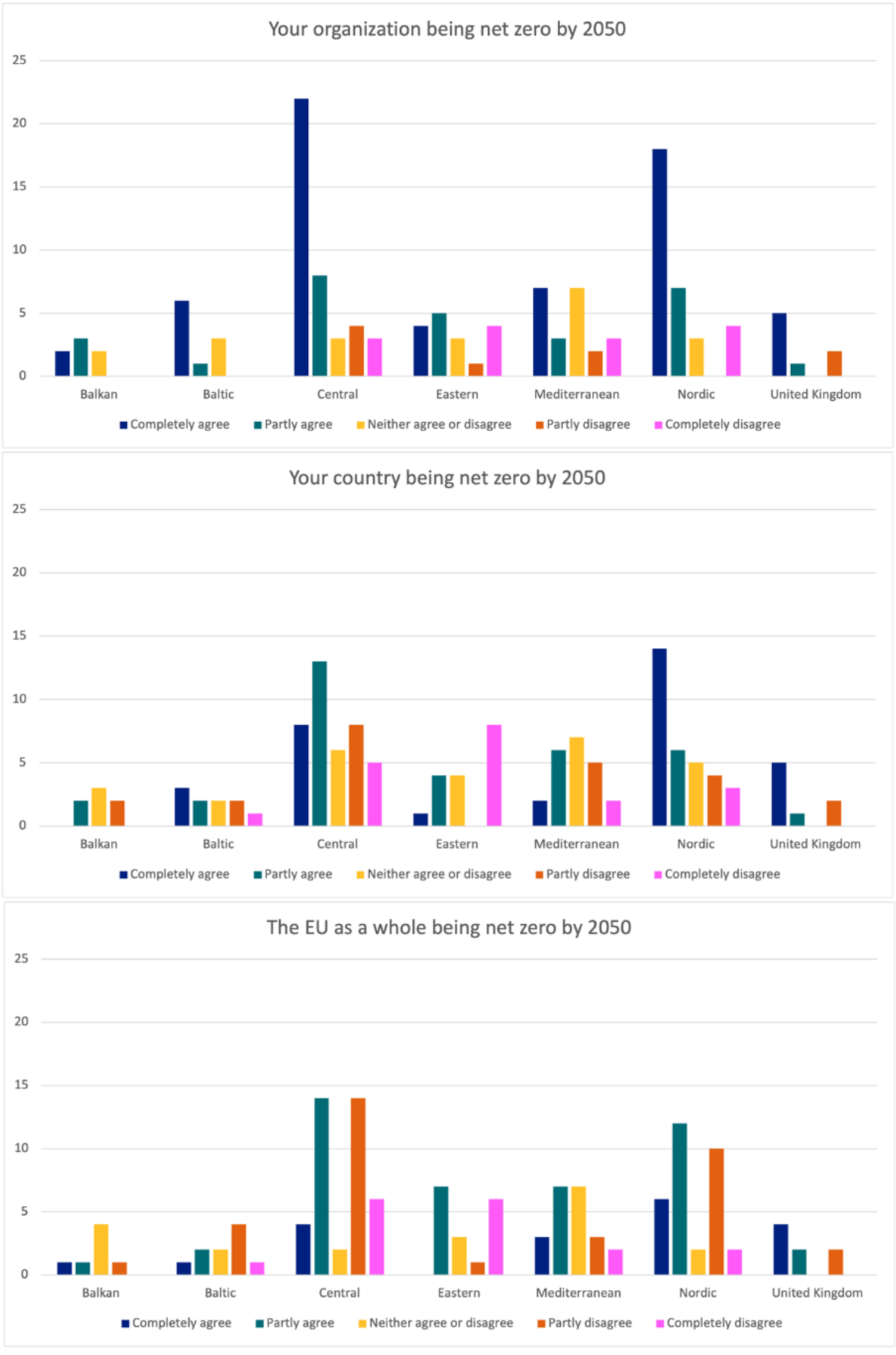

Figure 4.32: Question 22: How achievable do you think are the following scenarios? (1 choice for each row) - answers by geography [own elaboration]

Another possible analysis is to visualize how the perception of the EU Green Deal itself varies depending on the geographical area.

In each geographical area, respondents appear concerned that the EGD may create disparities among EU regions and countries. A similar pattern of responses for each geographical area was found in the next question ("The EGD is NOT promoting common incentives across the EU"): therefore, those who are convinced that the incentives are not balanced typically believe that this will lead to disparities in the long run.

For most respondents, the EGD is difficult to enforce and requires complex coordination among EU member states, especially according to Baltic and Central European countries. At the same time, except for companies located in Nordic countries, SMEs believe that the implementation of the EGD is well financially supported by the EU.

In particular, the UK and Nordic countries do not consider that the EGD's goals are too ambitious. This response is consistent with the graphs in the previous section, where these same geographical areas had shown more confidence in their ability to achieve climate neutrality by 2050. As for the last question, namely the possibility that the EGD will create a more predictable and clearer regulatory environment, there are no significant differences in percentage terms in the responses of various companies.

Figure 4.33: Question 21: How much would you agree with the following statements about the EU Green Deal (EGD)? (1 choice for each row) - answers by geography [own elaboration]

Clusterization by taxonomy

A final relevant example aims to highlight how, starting from the same question, multiple interpretations are possible: both by using cluster analysis based on geography, as already done previously, and by considering the sector.

The question under analysis is the fourth in the questionnaire, with the aim of identifying how three types of uncertainty (technological, regulatory, and market-related) impact the operations of SMEs in Europe.

Technological uncertainty had already emerged as one of the main operational complexities that highly innovative companies, such as those operating in the cleantech sector, must face. Looking at the data by

geographical region, the Balkans and Eastern Europe emerge as regions where there are more difficulties from this perspective, while the Baltic regions are the least affected. Analyzing the data by sector, those involved in sustainable transport would stand out for facing fewer challenges compared to others; however, their sample is particularly small. Following, in terms of lower impact, are those engaged in industrial energy management and environmental management (categories for which the response rate is also more significant).

Regulatory uncertainty has often been highlighted in the literature review and in this thesis. Compared to others, the Mediterranean and Nordic regions declare to be less affected. Looking at the data by sector, it can be observed that both categories related to energy management (3- industrial energy management and 6- energy management of buildings) seem to be less impacted than others.

Finally, regarding market uncertainty, among the various nations, none stands out negatively or positively. If we look at the data by sector, it is noted that resource preservation and energy management of buildings are much less impacted.

Figure 4.34: Question 4: How much the following types of uncertainty are affecting your activities? (1 choice for each row) - answers by geography and by taxonomy [own elaboration]

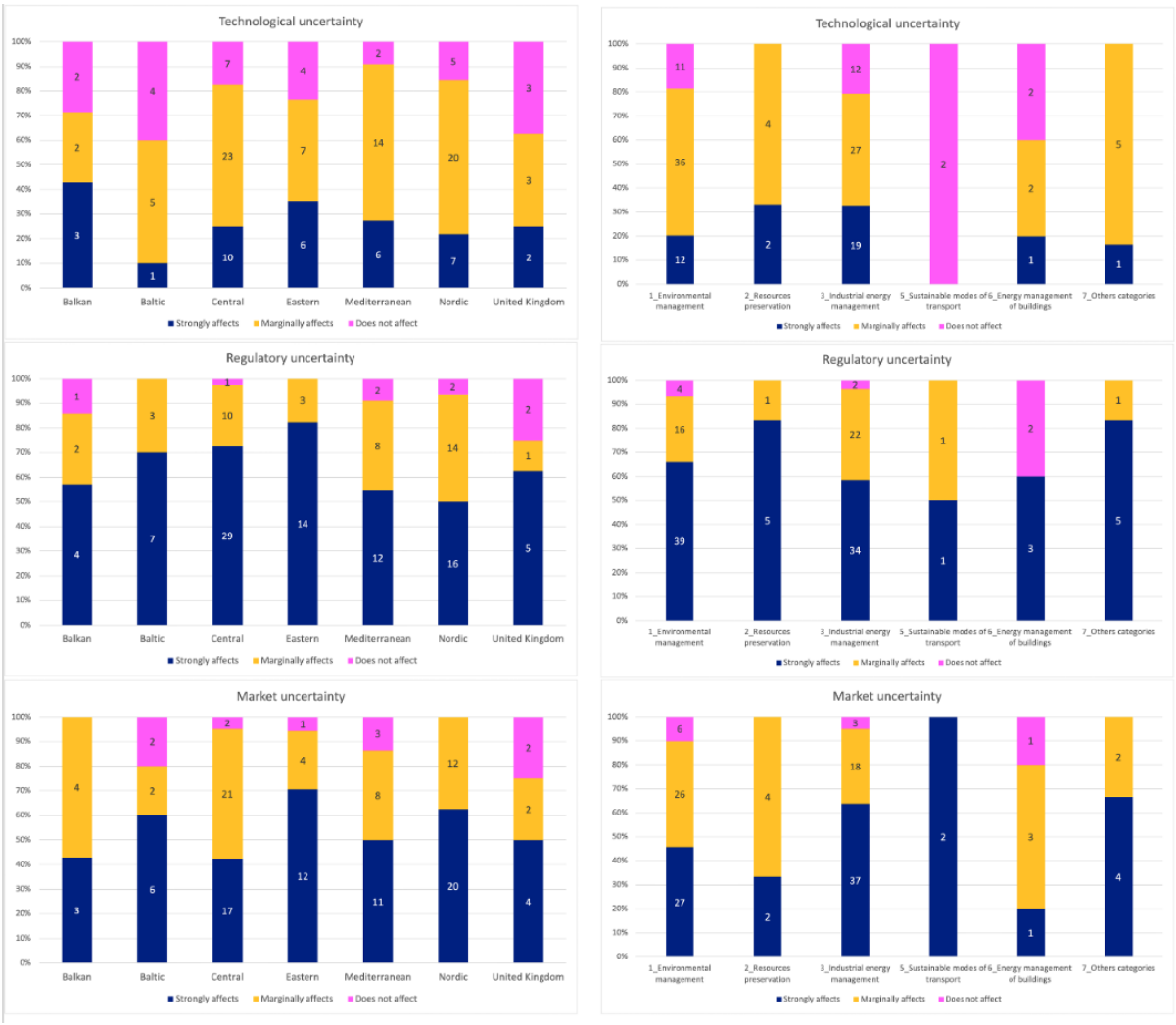

Figure 4.35: Question 4: How much the following types of uncertainty are affecting your activities? (1 choice for each row) - answers by geography and by taxonomy in percentage [own elaboration]

Chapter 5

Budget summary

The EIB University Research Sponsorship (EIBURS) programme provides grants to help EU universities and academic research centres to develop knowledge on topics of major interest to the EIB Group (EIB and EIF). An EIBURS is a research grant of up to €100,000 a year, for a period of three years. Politecnico di Torino is one of the most recent grant winners, awarded the research grant on "The European Cleantech industry, the EU Green Deal, and SME equity demand (CLEU)"[114].

The total cost of the CLEU project is €300,000. The cost related to survey development and administration is €13,600, divided into two research grants. The fellows were responsible for developing and distributing the questionnaire, sending out reminders, and supporting the research team in data analysis and the creation of the research report.

Chapter 6

Analysis of environmental and social implications

The United Nations' Sustainable Development Goals (SDGs) [115] are a roadmap for creating a better and more sustainable future for everyone. The 17 Goals are interconnected, and achieving all of them by 2030 is essential to ensure that no one is left behind. Among those most closely related to the topics addressed in this thesis, and to which the development of clean technologies could contribute, the following SDGs stand out:

- Goal 7: ensure access to clean and affordable energy;
- Goal 8: promote inclusive and sustainable economic growth, employment, and decent work;
- Goal 11: make cities and human settlements inclusive, safe, resilient, and sustainable;
- Goal 12: ensure sustainable consumption and production patterns;
- Goal 13: take urgent action to combat climate change and its impacts;
- Goal 14: dedicate efforts to the conservation and sustainable use of oceans, seas, and marine resources;
- Goal 15: focus on the preservation of life on land, including the protection and restoration of terrestrial ecosystems, sustainable forest management, combating desertification, halting and reversing land degradation, and preventing the loss of biodiversity.

The growth trajectory of cleantech companies will be significantly influenced by factors such as the local availability of investors, environmental contingencies, and public policies [116]. Consequently, the main environmental and social impacts of the survey and this thesis are expected to result from the **formulation of policy recommendations targeting cleantech SMEs** reported in the following chapter.

Chapter 7

Conclusion

7.1 Main findings

A total of 332 companies hailing from 25 European countries participated, with Italy, Sweden, and Germany contributing one-third of the total responses.

The majority of companies (73 percent) viewed engagement in cleantech as integral to their mission and vision. Specifically, about one-third of them offered green products or services, and one-quarter utilized green technologies. Additionally, some companies embraced green procurement policies (17 percent) and engaged in carbon offsetting (10 percent). The majority of interviewed companies were involved in clean technologies with a TRL greater than 6, and TRL 9 emerged as the most common. Research and Development conducted internally and joint R&D projects were the preferred methods, while the protection of results typically involved the use of patents, trademarks, and trade secrets.

Primary motivations for operating in cleantech also included business opportunities (59 percent) and compliance with regulations (27 percent). However, the cleantech sector exposed companies to challenges such as stringent regulations (22 percent), technological complexity (17 percent), and limited access to external financing (17 percent).

Specifically, concerning regulations, environmental policies had the most substantial impact, followed by regulations pertaining to product safety and operational safety. Commonly reported negative effects included administrative burden (33 percent) and operational uncertainty (26 percent) due to regulations. On the positive side, tax incentives (21 percent), direct policies (21 percent), and new regulations (16 percent) were suggested as effective means for supporting technology development.

Turning to the second pillar of the EGD focused on speeding up access to finance, 66 companies expressed intentions to raise external funds, primarily in the range of millions of euros. However, a majority found the application process to be time-consuming and complex (63 percent), with a perceived high level of competition (14 percent). Consequently, companies currently rely on internal financing, bank debt, and grants, while considering future options like green/ESG bonds and hybrid financing.

In addressing the third pillar, which revolves around enhancing skills, it has been reported that, on average 53 percent of required skills were available, with design (15 percent) and intellectual property (13 percent) facing higher shortages.

Finally, exploring the fourth pillar related to promoting open trade for resilient supply chains, it was discovered that few companies maintained local supply chains, while the majority (85 percent) limited

their supply chain within European borders. The main drivers of purchasing choices were quality (29 percent) and price (25 percent). Suggestions to enhance supply chain resilience included better trade and investment policies (33 percent) and critical infrastructure interventions (25 percent). Companies typically implemented selective risk-taking (29 percent) and hedging (21 percent) to safeguard their supply chain.

Most companies found the Green Deal objectives and measures transparent. Respondents expressed confidence in the EGD creating a clear regulatory environment but raised concerns about ambitious goals. While optimistic about their organizations achieving net-zero emissions, they were less confident about their nations and the EU achieving the same.

7.2 Areas of future research

The administration of the survey is propaedeutical to subsequent tasks belonging to the same research line, which include:

- Mapping of the transformative climate and innovation actions of European cleantech firms with innovative visualization tools (e.g., Flourish, Tableau) and techniques (e.g., bar chart races, Sankey diagrams, arc maps);
- Identification of the environmental impact of cleantech firms' entrepreneurial activity based on several indicators on the environment from the OECD data-set on "Regional social and environmental indicators 2021".

The next research lines to be developed are:

- *"The enabling factors for the development of cleantech firms"*, to explore the effects of implementing targeted policies and regulations, along with the impact of various sources of financing on the financial and innovative performance of cleantech firms;
- *"Policies, equity offer and equity demand"*, to determine the extent to which the implementation of policies and regulations influences both the willingness of cleantech firms to seek external equity financing and the availability of equity from venture capitalists (VCs).

7.3 Suggestions for improving response rate

From the experience gained in creating and distributing this survey, a series of suggestions arise, both for colleagues who will be developing other research within the same research project and for anyone tasked with presenting a survey to a sample that includes small and medium-sized enterprises operating in a highly innovative sector such as cleantech.

It is easy to notice that the response rate in Italy has been particularly high. This could be linked to the fact that in the introduction to the survey, the three Italian universities participating in the project were mentioned. The Italian respondent, recognizing the authority of these entities, understood the importance of the survey itself, making them more inclined to contribute. This suggests that greater involvement of local institutions or industry associations in the various involved nations can increase the survey's relevance to participants, encouraging them to respond.

Furthermore, Qualtrics offers the possibility of distributing the same survey in multiple languages. The level of English proficiency, in fact, is not the same across various European nations, and this can negatively impact the ability to represent the various nations equally. The European Union itself funds several

programs aimed at learning English because it not only opens up relational and knowledge perspectives without territorial boundaries, but there are correlations between English language proficiency and the level of innovation and research in a country. Therefore, conducting a survey only in English could lead to a self-selection bias.

Of course, the highly personalized follow-ups sent in the last few days when the survey was active proved to be very efficient in terms of responses obtained per number of emails sent. It is not, of course, a strategy that can be applied on a large scale, but it is known that people are more likely to open an email when they feel a personal connection. Therefore, if the survey's target is smaller than considered in this thesis, it is strongly recommended to customize the email as much as possible: explaining, on a case-by-case basis, the benefits of participating in the survey and the reduced cost in terms of time (for example, specifying how few questions remain for the respondent to complete the survey they had started, as done by us).

Finally, although the survey was distributed over a very extended period, part of it coincided with the summer holiday season in some European nations. Additionally, the same sample developed by other collaborators of the CLEU Research Project, given its significant utility, was used by European institutions to conduct another survey, thereby increasing the effort required of respondents.

Appendix A

Appendix

A.1 Survey

A.1.1 Introduction

Welcome to the Survey on the "**Cleantech industry in the European Green Deal**", a project coordinated by **Politecnico di Torino** in partnership with **Politecnico di Milano** and **University of Bologna**, sponsored by the European Investment Bank (EIB https://www.eib.org) and run in collaboration with the European Investment Fund (EIF https://www.eif.org). You have been selected to participate in this Europe-wide survey, the purpose of which is to assess the drivers, obstacles and policy landscape for the cleantech industry.

Why should you take part?

- The responses to the survey will help the EIF and the EIB to further develop their support for the cleantech field and contribute to the European cleantech ecosystem!
- You will receive a report of the survey results.

Your answers to this voluntary survey will be treated in strict confidence, only used for research purposes and published in aggregated form only. Your contribution and time are very valuable for the richness of the survey's findings. If you have any questions or troubles, please feel free to contact us.

The survey is designed to take approximately **5 minutes** to complete. There are no right or wrong answers to the survey questions. We are simply seeking your opinion.

If you are not the relevant contact point, we would be pleased if you could direct us to a relevant representative within your organization for this inquiry.

For any kind of clarification, or if you do not wish to be contacted for this research project, you can notify directly to eiburs@polito.it.

A.1.2 The company

Your business has been identified as cleantech based on the business description in company accounts.

In our classification of cleantech we refer to: *"(new) sustainable technologies and solutions able to offer the market a diverse range of products, processes and services to provide higher environmental performances. Cleantech is based on challenges such as reducing the use of natural resources, lowering the*

energy consumption, improving energy generation cycles and cutting or eliminating emissions, pollutants, and wastes".

Since the survey grounds on this definition, please refer to (the part of) your business that is more related with this.

1. Concerning the decision to operate in the cleantech sector, which of the following statement is mostly appropriated? (1 choice)

- ◯ My company does not operate in the cleantech sector
- ◯ My company always had its core business in the cleantech sector
- ◯ My company switched ALL of its activities to the cleantech sector at some point in time
- ◯ My company switched PART of its activities to the cleantech sector at some point in time
- ◯ Other (please specify)

Skip To: End of Survey if 1. Concerning the decision to operate in the cleantech sector, which of the following statement i... = My company does not operate in the cleantech sector

2. What are the main drivers for your company to operate in the cleantech sector? (from 1 to 3 choices)

- ◯ Enhanced business opportunities (new or existing)
- ◯ Pressure from stakeholders
- ◯ Compliance with regulations and standards
- ◯ Public sector incentives
- ◯ Brand reputation
- ◯ Company mission and vision
- ◯ Financial motives
- ◯ Other (please specify)

3. What are the main difficulties your company faced after you entered the cleantech sector? (from 1 to 3 choices)

- ◯ Lack of demand for cleantech products/services
- ◯ Lack of suppliers with a sustainable orientation
- ◯ Shortage of highly skilled workers
- ◯ Limited access to external financing
- ◯ Stringency or uncertainty of standards and regulations
- ◯ Complexity of developing technologies
- ◯ Inadequate intellectual property regimes
- ◯ Other (please specify)

4. How much the following types of uncertainty are affecting your activities? (1 choice for each row)

	Does not affect	Marginally affects	Strongly affects
TECHNOLOGICAL uncertainty (due to technological constraints and limitations)	◯	◯	◯
MARKET uncertainty (due to volatility in the market)	◯	◯	◯
REGULATORY uncertainty (due to unpredictability of policy-maker decisions)	◯	◯	◯

5. The European Green Deal is a package of policy initiatives, which aims to set the EU on the path to a green transition, with the ultimate goal of reaching climate neutrality by 2050. What is your company doing to meet the goals set by the European Green Deal? (from 1 to 3 choices)

◯ Using green technologies (new or existing)

◯ Using sustainable suppliers and procurement policies

◯ Offering green products/services

◯ Offsetting carbon emissions

◯ Encouraging remote working

◯ Upskilling workforce

◯ Other (please specify)

A.1.3 Innovation

The following questions are dedicated to the clean technologies your company is developing.

6. N.B. The Technology Readiness Level (TRL) is a measure from 1 to 9 assessing technology maturity. Each level represents a specific stage of development and testing of a technology, with higher levels indicating more advanced and closer-to-market technologies. How would you define the readiness level of the CORE CLEAN TECHNOLOGY embedded in the company's main project (TRL) ? (1 choice)

◯ MY COMPANY DOES NOT DEVELOP CLEAN TECHNOLOGIES

◯ TRL1 basic principles observed

◯ TRL2 technology concept formulated

◯ TRL3 experimental proof of concept

◯ TRL4 technology validated in lab

◯ TRL5 technology validated in relevant environment

◯ TRL6 technology demonstrated in relevant environment

◯ TRL7 system prototype demonstration in operational environment

◯ TRL8 system complete and qualified

◯ TRL9 actual system proven in operational environment

Display This Question: If 6. N.B. The Technology Readiness Level (TRL) is a measure from 1 to 9 assessing technology maturi... != MY COMPANY DOES NOT DEVELOP CLEAN TECHNOLOGIES

7. Referring to your cleantech products or services recent innovations, has your company recently engaged in the following innovation activities? (1 choice for each row)

	Yes	No
In house R&D	◯	◯
Joint R&D projects	◯	◯
Industrial partnerships (joint ventures, alliances) and/or M&A	◯	◯
External consultancy	◯	◯
Universities/research centers collaboration	◯	◯

Display This Question: If 6. N.B. The Technology Readiness Level (TRL) is a measure from 1 to 9 assessing technology maturi... != MY COMPANY DOES NOT DEVELOP CLEAN TECHNOLOGIES

8. What has your company done to protect its cleantech intellectual property? (1 choice for each row)

	Yes	No
Apply for a patent	◯	◯
Apply for a utility model	◯	◯
Register an industrial design	◯	◯
Register a trademark	◯	◯
Use trade secrets	◯	◯
Claim copyright	◯	◯

A.1.4 The 4 pillars

Regulatory environment

9. How much are regulations/policies on the below area affecting your cleantech activities? (1 choice for each row)

	Does not affect	Marginally affects	Strongly affects
Product safety	◯	◯	◯
Consumer protection	◯	◯	◯
Operational and worker safety	◯	◯	◯
Environmental	◯	◯	◯
Intellectual property	◯	◯	◯
Tax	◯	◯	◯
Employment	◯	◯	◯
New technologies introduction and development	◯	◯	◯

10. What are the undesirable effects of recent regulations/policies on your cleantech activities? (from 1 to 3 choices)

◯ Obstruct the innovation

◯ Create operational uncertainty

◯ Generate an excessive administrative burden

◯ Generate an unbalanced competition with extra-EU companies

◯ There are NOT undesirable effects

◯ Other (please specify)

11. Which of these regulations/policies can mostly support technological development in the cleantech sector? (from 1 to 3 choices)

◯ Direct policies (e.g. grants)

◯ Tax incentives (e.g. tax breaks)

◯ Boosting outcomes (e.g. no income tax, hyper amortization)

◯ Public procurement (e.g. the State creates an early market)

◯ Regulation/standardization (e.g. the State issues product-specific regulation)

◯ Development of complementary assets (e.g. Infrastructure for recharging electric vehicles)

◯ Governmental guidelines for the measurement and the report of environmental performance

◯ Dialogue and networking to enhance international co-operation

12. Referring to the main regulations/policies relevant to your core cleantech activities, how much do you agree on the following statements? (1 choice for each row)

	Completely disagree	Partly disagree	Neither agree or disagree	Partly agree	Completely agree
Definitional details are clearly stated (e.g. Definitions, main entities involved, exceptions, taxonomy)	◯	◯	◯	◯	◯
The objectives are set in a transparent and clear way	◯	◯	◯	◯	◯
The scope is clearly designed (territory, duration and addressees)	◯	◯	◯	◯	◯
The prioritization of goals and measures is well defined	◯	◯	◯	◯	◯
They are practically enforceable	◯	◯	◯	◯	◯
The monitoring activities are clearly disclosed	◯	◯	◯	◯	◯

Access to funding

13a. Does your company have any plans to raise funds from EXTERNAL investors for its ongoing activities? (1 choice)

◯ Yes

◯ No

◯ I do not know

Display This Question: If 13a. Does your company have any plans to raise funds from EXTERNAL investors for its ongoing acti... = Yes

13b. How much do you want to raise for your activities in the next five years? (1 choice)

◯ $<$ 500k€

◯ 500k€-2M€

◯ 2M€-5M€

◯ 5M€-10M€

◯ 10M€-50M€

◯ > 50M€

◯ I prefer not to answer

Display This Question: If 13a. Does your company have any plans to raise funds from EXTERNAL investors for its ongoing acti... = Yes

13c. How much of the funding you intend to raise will be dedicated to support cleantech activities? (1 choice)

◯ 0%

◯ 1-25%

◯ 26-50%

◯ 51-75%

◯ 76-100%

14. What is the main challenge in participating in public funding programmes? (1 choice)

◯ Lack of awareness of their existence

◯ Time consuming and complex application process

◯ High competitiveness

◯ We did not experience any difficulty

◯ Other (please specify)

15. Has your company used or would consider using the following financing instruments? (1 choice for each row)

	Used	Would consider using	Would never use
Internal financing	◯	◯	◯
Bank debt	◯	◯	◯
Private/venture debt	◯	◯	◯

Equity	○	○	○
Asset-based finance (e.g. leasing and hire purchases, factoring and invoice discounting)	○	○	○
Online alternative finance (e.g. crowdfunding)	○	○	○
Grants	○	○	○
Hybrid financing instruments (e.g. tax deductibility, convertible loans)	○	○	○
Green/ESG bonds	○	○	○

Skills

16. State if the skills listed are needed in your company and if you are going to outsource them (1 choice for each row)

	Needed and already available	Needed and will be internally provided	Needed and will be outsourced	Not needed
Data science and business intelligence skills	○	○	○	○
Technology and engineering skills	○	○	○	○
Design skills	○	○	○	○
Finance and accounting skills	○	○	○	○
Legal skills	○	○	○	○
Marketing and PR skills	○	○	○	○
Research and science skills	○	○	○	○
Business and strategic planning skills	○	○	○	○
Intellectual Property management skills	○	○	○	○
Sustainability skills	○	○	○	○
Soft skills (communication, problem solving, teamwork)	○	○	○	○

Supply chain

17. Where are your suppliers mainly localized? (1 choice)

- ◯ Locally /within the region
- ◯ Nationally
- ◯ EU
- ◯ Extra EU

18. Which are the main reasons for the selection of the current pool of suppliers? (from 1 to 3 choices)

- ◯ Price
- ◯ Physical proximity
- ◯ Ease of doing business
- ◯ Cultural affinity
- ◯ Quality
- ◯ Sustainability
- ◯ Other (please specify)

19. Which of the following policy goals should the government pursue to improve the resilience of supply chains in your country? (from 1 to 3 choices)

- ◯ Lower the costs and increase access to digital trade
- ◯ Implement trade facilitation measures: streamline and automate border processes
- ◯ Ensure stable, transparent, and predictable trade and investment policies
- ◯ Work on critical infrastructures: prescriptive regulatory tools, compensation mechanisms, and voluntary frameworks
- ◯ Ensure the supply of essential goods
- ◯ None of the above
- ◯ Other (please specify)

20. Which of the following actions is YOUR COMPANY considering to make its supply chain more resilient? (from 1 to 3 choices)

- ◯ Postponement (producing or shipping goods once customer orders are received)
- ◯ Selective risk-taking (producing or shipping goods based on anticipated customer demand)
- ◯ Hedging (diversifying suppliers and location of production)
- ◯ Control (through vertical integration of main suppliers)
- ◯ Transferring or sharing risks (via outsourcing and offshoring)
- ◯ Security (identifying shipments at risk, facilitated by information technology)
- ◯ None of the above
- ◯ Other (please specify)

A.1.5 The responder

21. How much would you agree with the following statements about the EU Green Deal (EGD)? (1 choice for each row)

	Completely disagree	Partly disagree	Neither agree or disagree	Partly agree	Completely agree
The EGD is difficultly enforceable	○	○	○	○	○
The EGD's goals are too ambitious	○	○	○	○	○
The EGD will create a more predictable and clearer regulatory environment	○	○	○	○	○
The EGD is NOT promoting common incentives across the EU	○	○	○	○	○
The implementation of the EGD is not financially supported by the EU	○	○	○	○	○
The EGD creates disparities among EU regions and countries	○	○	○	○	○
The EGD requires a difficult coordination among the EU member states	○	○	○	○	○

22. How achievable do you think are the following scenarios? (1 choice for each row)

	Completely disagree	Partly disagree	Neither agree or disagree	Partly agree	Completely agree
The EU as a whole being net zero by 2050	○	○	○	○	○
Your country being net zero by 2050	○	○	○	○	○

Your organization being net zero by 2050	◯	◯	◯	◯	◯

At the bottom some optional questions so that we can get back in touch for further information and a possible interview.

23. What is your position in the company? (Please, specify both the role and the business unit)

24. What is your name and surname?

25. What is your email address?

26. What is your phone contact? (Please, remember to specify the national prefix e.g. +39 3331234567)

A.2 Email

Dear *[Recipient's name]*,

We sincerely thank you for starting to fill out our survey. We appreciate the time you have taken to share your opinions and experiences with us.

Currently, there are only *[number of responses missing]* **responses left to complete the survey.** Your full participation is essential to ensure the highest quality of the information we are collecting.

We kindly ask you to take a few extra minutes to answer the remaining questions. The answers you have already provided have been recorded. If you don't need to make any corrections, feel free to proceed with the survey until you encounter the first unanswered question. **Your contribution is extremely important to us and will help shape the future of the European cleantech ecosystem!**

To complete the survey, please follow the link: *[link]*

Thank you again for your cooperation.

Best regards,
Eiburs research team

Bibliography

[1] European Environment Agency. Trends and projections in europe 2022. https://www.eea.europa.eu/publications/trends-and-projections-in-europe-2022, October 2022. Accessed on September 2023.

[2] Thomas Pellerin-Carlin Ciarán Humphreys. Eu public finance landscape for cleantech. https://eu.boell.org/en/factsheet-cleantech-funding, 2023. Accessed on October 2023.

[3] European Environment Agency. Climate change impacts, risks and adaptation. https://www.eea.europa.eu/en/topics/in-depth/climate-change-impacts-risks-and-adaptation, June 2023. Accessed on September 2023.

[4] European Commission. Supporting climate action through the eu budget. https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/supporting-climate-action-through-eu-budget_en#:~:text=This%20unprecedented%20response%20will%20help,spent%20to%20fight%20climate%20change. Accessed on September 2023.

[5] Cleantech for europe. https://www.cleantechforeurope.com. Accessed on October 2023.

[6] Cleantech for europe summit. https://www.cleantechforeurope.com/summit. Accessed on October 2023.

[7] H2 green steel. https://www.h2greensteel.com. Accessed on October 2023.

[8] Enapter. https://www.enapter.com/it. Accessed on October 2023.

[9] Plastic energy. https://plasticenergy.com/team/. Accessed on October 2023.

[10] Cleantech friendship group. https://www.cleantechfriendshipgroup.eu. Accessed on October 2023.

[11] Department of management and production engineering (digep) - politecnico di torino. https://www.digep.polito.it/en/. Accessed on October 2023.

[12] Department of management, economics and industrial engineering (dig) - politecnico di milano). https://www.som.polimi.it/en/the-school/about-us/dig/. Accessed on October 2023.

[13] Department of management (disa) - alma mater studiorum università di bologna. https://www.eib.org/en/index.htm. Accessed on October 2023.

[14] European Commission. European green deal industrial plan. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan_en. Accessed on September 2023.

[15] European Commission. The green deal industrial plan: putting europe's net-zero industry in the lead. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510, 2023. Accessed on September 2023.

[16] The organisation for economic co-operation and development (oecd). https://www.oecd.org. Accessed on October 2023.

[17] OECD. The OECD Reference Checklist for Regulatory Decision-making: A Draft Recommendation of the OECD, PUMA. Technical report, OECD, Paris, 1994.

[18] Peter Swann. Do standards enable or constrain innovation? In *The Empirical Economics of Standards*, pages 76–120. Department of Trade and Industry, London, 2005.

[19] Kevin Koch, Mohammed Rafiquzzaman, and Someshwar Rao. The impact of regulatory policies on innovation: Evidence from g-7 countries. Technical report, Industry Canada, Ottawa, 2004.

[20] Paul Geroski. Innovation and sectoral sources of uk productivity growth. *Economic Journal*, 101:1438–1451, 1991.

[21] Andrea Bassanini and Ekkehard Ernst. Labour market institutions, product market regulation, and innovation: Cross country evidence. ECO/WKP (2002)2, OECD, Paris, 2002.

[22] EIB Economics Department. European firms and climate change 2020/2021. https://www.eib.org/attachments/publications/eibis_2020_report_on_climate_change_en.pdf. Accessed on September 2023.

[23] Knut Blind. 15. the impact of regulation on innovation. *Handbook of innovation policy impact*, 450, 2016.

[24] British Chambers of Commerce. Burdens barometer 2002. http://www.britishchambers.org.uk/cutredtape, 2002. Accessed on September 2023.

[25] Michael E Porter and Claas van der Linde. Toward a new conception of the environment-competitiveness relationship. *Journal of economic perspectives*, 9(4):97–118, 1995.

[26] Jean Olson Lanjouw and Ashoka Mody. Innovation and the international diffusion of environmentally responsive technology. *Research policy*, 25(4):549–571, 1996.

[27] Stuart Hart and Gitanjali Ahuja. Does it pay to be green? an empirical examination of the relationship between emission reduction and firm performance. *Business Strategy and the Environment*, 5:30–37, 1996.

[28] S. B. Brunnermeier and M. Cohen. The determinants of environmental innovation in us manufacturing industries. *Journal of Environmental Economics and Management*, 45:278–293, 2003.

[29] David Popp. Induced innovation and energy prices. *American Economic Review*, 92(1):160–180, 2002.

[30] David Popp. International innovation and diffusion of air pollution control technologies: the effects of nox and so2 regulation in the us, japan, and germany. *Journal of Environmental Economics and Management*, 51(1):46–71, 2006.

[31] David C. Popp, Tamara Hafner, and Nick Johnstone. Policy vs. consumer pressure: innovation and diffusion of alternative bleaching technologies in the pulp industry. Technical report, NBER Working Paper, No. W13439, 2007.

[32] Paul Lanoie, Michel Patry, and Robert Lajeunesse. Environmental regulation and productivity: testing the porter hypothesis. *Journal of Productivity Analysis*, 30(2):121–128, 2008.

[33] Johannes Eugster. *The impact of environmental policy on innovation in clean technologies*. International Monetary Fund, 2021.

[34] European Commission. Investment needs assessment and funding availabilities to strengthen eu's net-zero technology manufacturing capacity. https://single-market-economy.ec.europa.eu/publications/staff-working-document-investment-needs-assessment-and-funding-availabiliti en.

[35] Organization for Economic Cooperation and Development (OECD). Chapter 4. pillar c – access to finance. https://www.oecd-ilibrary.org/sites/a0596eb4-en/index.html?itemId=/content/component/a0596eb4-en, 2023. Accessed on October 2023.

[36] Nancy MP Bocken. Sustainable venture capital–catalyst for sustainable start-up success? *Journal of cleaner production*, 108:647–658, 2015.

[37] Organization for Economic Cooperation and Development (OECD). Local employment and skills. https://www.oecd.org/cfe/leed/local-employment.htm, 2023. Accessed on September 2023.

[38] Organisation for Economic Co-operation and Development (OECD). Future-proofing adult learning systems in cities and regions: A policy manual for local governments. Technical Report 2022/03, OECD Local Economic and Employment Development (LEED) Papers, Paris, 2022. DOI: 10.1787/11fa26cc-en.

[39] Mark S Freel. Where are the skills gaps in innovative small firms? *International journal of entrepreneurial behavior & research*, 5(3):144–154, 1999.

[40] Ualison Rébula de Oliveira, Luciano Souza Espindola, Isabele Rocha da Silva, Iaslin Nostório da Silva, and Henrique Martins Rocha. A systematic literature review on green supply chain management: Research implications and future perspectives. *Journal of cleaner production*, 187:537–561, 2018.

[41] Margarita Pavlova. Fostering inclusive, sustainable economic growth and "green" skills development in learning cities through partnerships. *International Review of Education*, 64:339–354, 2018.

[42] Wen Jun, Waheed Ali, Muhammad Yaseen Bhutto, Hadi Hussain, and Nadeem Akhtar Khan. Examining the determinants of green innovation adoption in smes: A pls-sem approach. *European Journal of Innovation Management*, 24(1):67–87, 2019.

[43] Hasan Evrim Arici and Muzaffer Uysal. Leadership, green innovation, and green creativity: A systematic review. *The Service Industries Journal*, 42(5-6):280–320, 2022.

[44] Rudy Arthur. Studying the uk job market during the covid-19 crisis with online job ads. *PloS one*, 16(5):e0251431, 2021.

[45] Victoria Masterson. These are the skills young people will need for the green jobs of the future. https://www.weforum.org/agenda/2021/08/these-are-the-skills-young-people-will-need-for-the-green-jobs-of-the-futu 2021. Accessed on September 2023.

[46] Joshua Healy, Kostas Mavromaras, and Peter J. Sloane. Adjusting to skill shortages in australian smes. *Applied Economics*, 47(24):2470–2487, 2015.

[47] Derek Bosworth. Skill shortages in britain. *Scottish Journal of Political Economy*, 40:241–271, 1993.

[48] Francis Green, Stephen Machin, and David Wilkinson. The meaning and determinants of skills shortages. *Oxford Bulletin of Economics and Statistics*, 60:165–187, 1998.

[49] Chandralekha Shah and Gerard Burke. Skill shortages: Concepts, measurement, and policy responses. *Australian Bulletin of Labour*, 31:44–71, 2005.

[50] Emily Moriarty, James Wickham, Tracy Krings, et al. "taking on almost everyone?" migrant and employer recruitment strategies in a booming labour market. *The International Journal of Human Resource Management*, 23:1871–1887, 2012.

[51] John M. Oliver and John R. Turton. Is there a shortage of skilled labour? *British Journal of Industrial Relations*, 20:195–200, 1982.

[52] Organization for Economic Cooperation and Development (OECD). Innovation in skills development in smes. https://www.oecd.org/cfe/leed/TSME%20Highlights%20FINAL%20formatted.pdf, 2023. Accessed on October 2023.

[53] European Commission. Staff working document - strategic dependencies and capacities. https://commission.europa.eu/document/0a5bdf82-400d-4c9c-ad54-51766e508969_en, 2021. Accessed on October 2023.

[54] Jie Chen, Amrik Sohal, and Daniel Prajogo. Supply chain operational risk mitigation: A collaborative approach. *International Journal of Production Research*, 51(7):2186–2199, 2013.

[55] ManMohan S. Sodhi, B. Son, and C. Tang. Researchers' perspectives on supply chain risk management. *Production and Operations Management*, 21(1):1–13, 2012.

[56] Prerna Singhal, Gaurav Agarwal, and Manoj Mittal. Supply chain risk management: Review, classification and future research directions. *International Journal of Business Science and Applied Management*, 6(3):15–42, 2011.

[57] Tadeusz Sawik. Selection of resilient supply portfolio under disruption risks. *Omega*, 41(2):259–269, 2013.

[58] Christopher Tang. Perspectives in supply chain risk management. *International Journal of Production Economics*, 103(2):451–488, 2006.

[59] Kai Zhao, A. Kumar, Terry P. Harrison, and J. Yen. Analyzing the resilience of complex supply network topologies against random and targeted disruptions. *IEEE Systems Journal*, 5(1):28–39, 2011.

[60] Serguei Ponomarov and Mary C. Holcomb. Understanding the concept of supply chain resilience. *The International Journal of Logistics Management*, 20(1):124–143, 2009.

[61] Kathryn Stecke and S. Kumar. Sources of supply chain disruptions, factors that breed vulnerability, and mitigating strategies. *Journal of Marketing Channels*, 16(3):193–226, 2009.

[62] Stavros Ponis and E. Koronis. Supply chain resilience: Definition of concept and its formative elements. *Journal of Applied Business Research*, 28(5):921–930, 2012.

[63] Serguei Ponomarov. *Antecedents and Consequences of Supply Chain Resilience: A Dynamic Capabilities Perspective*. PhD thesis, University of Tennessee-USA, 2012.

[64] Christopher S Tang. Perspectives in supply chain risk management. *International journal of production economics*, 103(2):451–488, 2006.

[65] Martin Christopher and Helen Peck. Building the resilient supply chain. *The International Journal of Logistics Management*, 15(2):1–14, 2004.

[66] Timothy J Pettit, Joseph Fiksel, and Keely L Croxton. Ensuring supply chain resilience: development of a conceptual framework. *Journal of business logistics*, 31(1):1–21, 2010.

[67] M. Christopher and H. Peck. Building the resilient supply chain. *The International Journal of Logistics Management*, 15(2):1–14, 2004.

[68] N. Bakshi and P. Kleindorfer. Co-opetition and investment for supply chain resilience. *Production and Operations Management*, 18(6):583–603, 2009.

[69] Ozgur Erol, Brian J Sauser, and Mo Mansouri. A framework for investigation into extended enterprise resilience. *Enterprise Information Systems*, 4(2):111–136, 2010.

[70] Organization for Economic Cooperation and Development (OECD). Resilient supply chains: Procurement. `https://www.oecd.org/trade/resilient-supply-chains/procurement/`. Accessed on October 2023.

[71] Joao Pires Ribeiro and Ana Barbosa-Povoa. Supply chain resilience: Definitions and quantitative modelling approaches–a literature review. *Computers & industrial engineering*, 115:109–122, 2018.

[72] Organization for Economic Cooperation and Development (OECD). Keys to resilient supply chains. `https://www.oecd.org/trade/resilient-supply-chains/`. Accessed on October 2023.

[73] Marianne Schneider-Petsinger. Us and european strategies for resilient supply chains. *Research paper*, 2021.

[74] European Parliament. Resilience of global supply chains: Challenges and solutions. `https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698815`. Accessed on October 2023.

[75] Anastasia Rose O'rourke. *The emergence of cleantech*. Yale University, 2009.

[76] Ron Pernick and Clint Wilder. The clean tech revolution: The next big growth and investment opportunity. *(No Title)*, 2007.

[77] Shah Rukh Shakeel and Oskar Juszczyk. The role of venture capital in the commercialization of cleantech companies. *Management*, 14(4):325–339, 2019.

[78] Christian Koch, Bettina Foged Sørensen, and Merete Wildner. Cleantech niche development: a small business perspective on climate change. *International Journal of Global Warming*, 4(3-4):365–382, 2012.

[79] Delegation of the European Union to Canada. The clean technology market entry guide: A practical guide to the canadian clean technology market for european union companies. https://www.eeas.europa.eu/delegations/canada/successful-canada-eu-workshop-ceta-opportunities-clean-technology_en, May 2021. Accessed on September 2023.

[80] Liliana Doganova and Peter Karnøe. Building markets for clean technologies: Controversies, environmental concerns and economic worth. *Industrial Marketing Management*, 44:22–31, 2015.

[81] S.R. Shakeel. Cleantech: Prospects and challenges - letter from academia. *Journal of Innovation Management*, 9(2):VIII–XVII, 2021.

[82] Clentech Group sectors. Climate change impacts, risks and adaptation. https://www.cleantech.com/industries/. Accessed on September 2023.

[83] Douglas Cumming, Irene Henriques, and Perry Sadorsky. 'cleantech'venture capital around the world. *International Review of Financial Analysis*, 44:86–97, 2016.

[84] Douglas J Cumming, Gael Leboeuf, and Armin Schwienbacher. Crowdfunding cleantech. *Energy Economics*, 65:292–303, 2017.

[85] Teis Hansen. Juggling with proximity and distance: Collaborative innovation projects in the d anish cleantech industry. *Economic Geography*, 90(4):375–402, 2014.

[86] Christian Binz, Tian Tang, and Joern Huenteler. Spatial lifecycles of cleantech industries–the global development history of solar photovoltaics. *Energy Policy*, 101:386–402, 2017.

[87] Matthew Gray and Federico Caprotti. Cleantech clusters and the promotion of the low carbon transition: criteria for success and evidence from copenhagen, masdar and online platforms. *Carbon Management*, 2(5):529–538, 2011.

[88] Ivan Haščič and Mauro Migotto. Measuring environmental innovation using patent data. *OECD Environment Working Papers*, 2015. https://doi.org/10.1787/5js009kf48xw-en.

[89] Priscilla A Glasow. Fundamentals of survey research methodology. *Retrieved January*, 18:2013, 2005.

[90] Barbara B Flynn, Sadao Sakakibara, Roger G Schroeder, Kimberly A Bates, and E James Flynn. Empirical research methods in operations management. *Journal of operations management*, 9(2):250–284, 1990.

[91] Gary D Scudder and Craig A Hill. A review and classification of empirical research in operations management. *Journal of Operations Management*, 16(1):91–101, 1998.

[92] Markham T Frohlich. Techniques for improving response rates in om survey research. *Journal of Operations Management*, 20(1):53–62, 2002.

[93] Paul D. Larson. A note on mail surveys and response rates in logistics research. *Journal of Business Logistics*, 26(2):211–221, 2005.

[94] Jean M Converse and Stanley Presser. *Survey questions: Handcrafting the standardized questionnaire*, volume 63. Sage, 1986.

[95] Priscilla Salant and Don A Dillman. How to conduct your own survey. *(No Title)*, 1994.

[96] William H Walters. Survey design, sampling, and significance testing: Key issues. *The Journal of Academic Librarianship*, 47(3):102344, 2021.

[97] M Neil Browne, Terri J Keeley, and Wesley J Hiers. The epistemological role of expert witnesses and toxic torts. *Am. Bus. LJ*, 36:1, 1998.

[98] Floyd J Fowler. *Improving survey questions: Design and evaluation*. Sage, 1995.

[99] Douglas M. Lambert and Thomas C. Harrington. Measuring nonresponse bias in customer service mail surveys. *Journal of Business Logistics*, 11(2):5–25, 1990.

[100] J. Yu and H. Cooper. A quantitative review of research design effects on response rates to questionnaires. *Journal of Marketing Research*, 20(1):36–44, 1983.

[101] Thomas V Greer, Nuchai Chuchinprakarn, and Sudhindra Seshadri. Likelihood of participating in mail survey research: Business respondents' perspectives. *Industrial Marketing Management*, 29(2):97–109, 2000.

[102] Don A Dillman et al. *Mail and telephone surveys: The total design method*, volume 19. Wiley New York, 1978.

[103] Elke Deutskens, Ko de Ruyter, Martin Wetzels, and Pim Oosterveld. Response rate and response quality of internet-based surveys: an experimental study. *Marketing Letters*, 15(1):21–36, 2004.

[104] Matteo Ambrois, Vincenzo Butticè, Federico Caviggioli, Giovanni Cerulli, Annalisa Croce, Antonio De Marco, Andrea Giordano, Giuliano Resce, Laura Toschi, Elisa Ughetto, and Antonio Zinilli. Using machine learning to map the european cleantech sector. `https://www.oecd-ilibrary.org/sites/a0596eb4-en/index.html?itemId=/content/component/a0596eb4-en`, 2023. Accessed on October 2023.

[105] Kent State University. Statistical and qualitative data analysis software: About qualtrics. `https://libguides.library.kent.edu/statconsulting/qualtrics`. Accessed on October 2023.

[106] Don A Dillman. *Mail and Internet surveys: The tailored design method–2007 Update with new Internet, visual, and mixed-mode guide*. John Wiley & Sons, 2011.

[107] Philip Cleave. The best time to send a survey. `https://www.smartsurvey.co.uk/blog/the-best-time-to-send-a-survey#:~:text=While%20Monday%2C%20Tuesday%20and%20Thursday,times%20to%20send%20a%20survey.` Accessed on October 2023.

[108] Jill Zheng. What day of the week should you send your survey? `https://www.surveymonkey.com/curiosity/day-of-the-week/`. Accessed on October 2023.

[109] Qaultrics email distribution error messages. `https://www.qualtrics.com/support/survey-platform/distributions-module/email-distribution/email-distribution-error-messages/#DistributionStatuses`. Accessed on October 2023.

[110] Thomas D Cook, Donald Thomas Campbell, and William Shadish. *Experimental and quasi-experimental designs for generalized causal inference*, volume 1195. Houghton Mifflin Boston, MA, 2002.

[111] Steven A Melnyk, Thomas J Page, Sarah Jinhui Wu, and Laird A Burns. Would you mind completing this survey: Assessing the state of survey research in supply chain management. *Journal of Purchasing and Supply Management*, 18(1):35–45, 2012.

[112] European Commission. Internal market, industry, entrepreneurship and smes. `https://single-market-economy.ec.europa.eu/access-finance_en`, 2023. Accessed on October 2023.

[113] European Commission. Small and medium-sized enterprises' access to finance. European Semester Thematic Factsheet, 2017. Accessed on October 2023.

[114] European Investment Bank. Eiburs research grants 2022-2025 attributed. `https://institute.eib.org/2022/05/eiburs-research-grants-2022-2025-attributed/`. Accessed on October 2023.

[115] United Nations. Take action for the sustainable development goals. `https://www.un.org/sustainabledevelopment/sustainable-development-goals/`. Accessed on October 2023.

[116] A. Masini and E. Menichetti. The impact of behavioural factors in the renewable energy investment decision making process: Conceptual framework and empirical findings. *Energy Policy*, 40:28–38, 2012.