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Enablers of innovation IN energy transition

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Enablers of innovation in energy transition

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INTRODUCTION

Climate change: The problem we face

Climate change is one of the biggest global challenges facing our society. It is a problem that has effects on an international scale and that must be faced in decisive and urgent ways, given that it is causing increasingly severe and irreversible social, economic, and environmental impacts. It is the variation in the state of the climate due to the continual increase in the Earth's surface temperature due to increased emissions of greenhouse gases (GHG) of anthropogenic origin. Global warming generates extreme weather conditions, melting glaciers and rising sea levels. These abnormal weather conditions affect present and future generations and consequently have a greater impact on our economies, the environment, health and daily life.

The amount of GHG being released into the atmosphere has increased, mainly due to the use of fossil fuels. There have been calls for the energy sector, the main sector responsible for GHG emissions, to play a key role in facing the great challenge that humanity is up against. Similarly, the increasing awareness of the problem of environmental sustainability has led to successive international agreements to achieve clean and environmentally sustainable economic growth being established.

Although the global energy environment has changed more in recent years than in previous decades, there is a growing concern about climate implications within the context of the current energy situation, which has led to the need to accelerate the transition towards a new decarbonized economic model. There are many areas in which changes will need to be made. In the European case, the strategy defined for 2030 and 2050 shows how the path towards climate neutrality can be actioned from a community level by investing in realistic technological solutions, training citizens and harmonizing action in key areas such as industrial policy, financing or research, while guaranteeing social justice for a fair transition.

The community solution: A new model of governance towards decarbonisation

The change in the energy sector is seen in the firm commitment to developing energy technologies with low carbon emissions, as well as in the improvement of energy efficiency. These are aspects of the process towards the decarbonisation of the economy known as the Energy Transition. This process has required and will continue to require a strong push for innovation and a clear path upon which progress can be made.

In order to achieve these objectives in a coordinated manner between all Member States, a new model of governance has been established at a community level, which establishes the planning procedure that is needed to meet goals and objectives. This guarantees the coherence, equalisation and transparency of the information submitted to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement.

The European Union (EU) asks each Member State to draw up a National Energy and Climate Plan (NECP) that should enable the Commission to be able to determine the degree of joint compliance and establish actions to correct possible deviations. These ten-year plans mark a before and after point in innovation in the European Union. The emergence of NECPs stems from the "Regulation on the governance of the Energy Union and Climate Action" (EU) 2018/1999, which was agreed on as part of the package of clean energy measures for all Europeans, which was adopted in 2019 (*Clean energy for all Europeans*) [1].

Under the Governance Regulation, Member States were required to submit their draft NECPs for the period 2021-2030 to the European Commission before December 31, 2018. The Commission analysed the plans and also made specific recommendations for each country. They were then published in June 2019. Taking these recommendations into account, Member States were required to submit their final NECPs by December 31, 2019. On September 17, 2020, a detailed EU-wide assessment of the final NECPs was published. As

a follow-up to and as part of the Energy Union 2020 report, individual assessments of each of the national plans for further guidance were also published. Each country is required to submit a progress report every two years. The Commission will monitor the progress of the EU as a whole in terms of achieving the objectives as part of the report on the state of the energy union.

This national governance approach requires coordination of purpose across all government departments and provides a level of planning that will facilitate public and private investment. The NECPs have the objective of better integration of research, innovation and competitiveness of the EU countries, identification of the technologies that must continue to be developed and financed, as well as the cooperation and coordination mechanisms that can reinforce national efforts. To better develop and implement the plans, Member States needed to consult citizens, businesses and regional authorities in the drafting and finalisation process. The governance regulation also required Member States to present long-term national strategies for 2050 before the start of 2020.

The NECPs describe how EU countries intend to address energy efficiency, renewable energy, the reduction of greenhouse gas emissions, interconnections and research and innovation. Thus, technological innovation in the energy sector constitutes a strategic priority at a European level and must create a competitive environment facilitating the achievement of solutions to meet the double challenge that both the growing increase in demand and environmental concerns entail.

Innovation in this transition and planning framework: The object of this study

Given that innovation is one of the most relevant elements for the energy transition, this study aims to analyse the current state of innovation and identify the enabling factors for its development. It will focus on the state of research and innovation in the energy field of the Sudoe region, which is comprised of Spain, France and Portugal.

The report has been developed as part of the European project Tr@nsNet and is a continuation of the study on innovation " *White paper: An overview of innovation in the energy sector for the Sudoe regions*", which was published in 2019 within the framework of the Tr@nsEnergy project. Both of these projects have been financed with FEDER funds. The *White Paper* presents a vision of the solutions and recommendations for improving the current state of R+D+i [2]. As a way to further this research, this new report focuses on the situation of innovation in the Sudoe region within the context of the NECPs, focusing on three key aspects of the innovative environment:

I) Technological and social innovation derived from it.
II) Open innovation as a tool to encourage greater stakeholder participation.
III) The regulatory barriers innovators face when bringing their innovations to market.

This document is divided into two sections. The first presents a complete review of the state of innovation on a global level, contextualizing the importance of R+D+i as an endogenous factor that guarantees competitiveness and consequently economic growth. It also analyses open innovation trends and how this allows for the integration of all interested parties in the development of new solutions for the energy transition. The second section of the document presents the situation of innovation at a local level in the business and institutional fabric of Spain, France and Portugal. This section presents innovation management and the impact of NECPs on the innovation strategies of public and private stakeholders. The results of this study provide an advancement in the work of coupling technological innovation with regulatory innovation in order to bring to the market the solutions demanded by the environmental challenge and by consumers in the Sudoe region.

STATE OF INNOVATION ON A GLOBAL SCALE

1.1 The importance of R+D+i and related policy

Although this report does not intend to go into detail about the role that technological progress plays within the different theories of economic growth, a few comments about the evolution of R&D&i before going into detail about the situation of the energy sector do seem appropriate. It should be noted that the different contributions of economic theories indicate that technological progress is a key element in long-term growth, as is the possibility of having an economic environment characterized by the existence of external economies capable of generating innovation and disseminating the knowledge acquired [3].

The innovation capacity of an economy has a decisive influence on its productivity, generating business opportunities for both existing companies and newly created ones, providing them with greater flexibility to face the continuous changes that occur in the business environment, which ultimately contributes to the generation of employment opportunities for highly-skilled workers. There is no doubt that promoting an economy's capacity for innovation already provides justification in itself for the need for public intervention in this area, but there are other relevant arguments such as the existence of market failures. There is ample theoretical evidence that shows that the private benefits of investment in R&D are lower than the social benefits [4, 5], so that without public intervention it is very difficult to achieve the social optimum. Within the different possibilities, investment in R&D is the most effective way of accessing innovation because it strengthens the technological capacity of the company, as well as its capacity for innovation and learning, enables strategies with greater added value and, above all, distinguishes itself from other access routes to innovation, such as imitation.

Every innovation process in a company has four main economic characteristics, which affect the allocation of business resources to R&D activities and

which cause the private benefits of investment in R&D to be below their social optimum: I) the existence of indivisibilities (a minimum business dimension that allows the different R&D projects to be undertaken), II) the presence of uncertainty, III) the difficulty in completely appropriating the results of the research by those who carry it out , and IV) the existence of externalities.

The uncertain nature of this type of activity means that companies cannot predict the outcome of R&D. The success of an R&D project depends on a complex network of objective uncertainties (the state of the art, the market's response, etc.) and technological and business decisions, which do not guarantee success at any time.

This risk, as well as the non-recovery of investment in case of failure, can discourage business investment in this area. This is a reality in the case of small and medium-sized companies. Added to the risk generated by these uncertainties is one stemming from insecurity when fully appropriating the results. In other words, the company that has carried out the R&D project cannot be sure that the results will not be imitated, copied or replaced by other developments that satisfy the demand in an equal or superior way. This effect is largely due to fact that the search is of a public good nature and that R&D activities generate positive externalities or spillovers, from which other agents benefit.

Finally, and very closely linked to the nature of a public good, it should be noted that there are external economies in R&D activity. In other words, the results obtained can transcend the scope of action of the investing company and other companies can benefit from the new knowledge generated by the investing company. Taking all these considerations as a starting point, it is not surprising that companies that make their decisions based solely and exclusively on individual benefit and make investments below the socially desirable optimum. It is in this context that the need for public intervention is justified, not only in terms of promoting R&D, but with a much broader focus, trying to achieve proper functioning of the innovation system as a whole. Given the relevance of both research and innovation when it comes to

providing solutions to climate challenges while contributing to economic prosperity it is necessary to first provide an approach to innovation policy, paying special attention to the community case.

In the specific case of the European Union, the main objective of its technological research and development policy is to turn the region into a leading knowledge economy that contributes to individual and collective prosperity and well-being. In recent years, the community strategy has focused on the creation of a common research space that facilitates long-term maximum use of cooperation at the different levels of action, improvement in European and national policy coordination, consolidation of structural capacities and creation of networks of research teams.

Under this premise, and in order to continue advancing towards the innovation society, there are many initiatives launched, each with its own characteristics. From a strategic perspective, it is worth highlighting the European Strategic Energy Technology Plan (SET-PLAN). It is an initiative that aims to identify a common approach to promoting energy research based on the principles of integrating and coordinating research programs and budgets as well as existing innovation at both a national and community level [6]. The SET-PLAN is the cornerstone of the European Union's energy and climate policies, collecting recommendations that allow us to develop a portfolio of affordable, clean, efficient and low-carbon technologies through coordinated research. In short, it is a strategy to accelerate the development of these technologies and make them available to the market.

1.2 Current spending on research and development

Given the scarcity of reliable statistical sources, evaluating the results of the different policies to support innovation and technological development is complex. That said, different initiatives have recently been developed in order to identify shortcomings and recommendations when it comes to harmonizing statistical data related to R&D in the area of energy. In order to assess the

recent evolution of spending on research and development, this study is based on data relating to public budgets in the field of energy R&D which is published annually by the International Energy Agency (IEA). The data collected in the IEA Energy Technology R&D Statistics Database show the how the amount of public funds allocated to R&D projects in 27 IEA member states from 1974 to the present has changed. It constitutes, therefore, a good indicator of the weight of the sector within the national budgets to support research and development [7]. The main conclusions drawn from the analysis of these data are presented below.

According to the IEA, in 2020 the global public budget for energy research and development reached around USD 32.6 billion, confirming the upward trend that began in 2017 after several years of decline. Growth was mainly driven by Europe and the United States, while public spending on energy research and development remained steady in China after two years of strong growth in 2017-2018 and was higher than the country's plan for the next 5 years. The public budgets of the IEA countries for energy research, development and demonstration (RD&D) increased by 6% in 2020, rising to an estimated USD 23.1 billion. This was the fourth consecutive annual increase after five years of decline. The level in 2020 was 40% higher than 2008, though still lower than the 2009 peak.

Despite this evolution, current spending levels are nowhere near those of the 1970s and early 1980s. The sudden rise in oil prices at the end of 1973 and 1979 made those responsible for energy policy realise that it was necessary to adopt measures that aimed to modify energy demand patterns and reduce the huge dependency on oil by promoting alternative energy sources. Against this backdrop and in parallel with the implementation of plans to promote nuclear energy, the development of natural gas consumption and use of local coal resources for electricity, energy research development plans were launched, which was subsequently reflected in public budgets.

The drastic change in the world energy panorama in the second decade of

the 1980s, with the collapse of coal prices (in 1982) and of oil (in 1986) due to various reasons (the drop in demand, the increase in supply and the policy to promote other alternative energy sources etc.) triggered a reduction of political interest in programs to promote research and technological development in the energy field. Interest in this area has increased again in recent years, as can be seen in the changes in public spending on research and development. This is due to political concern about the effects derived from climate change and the need to provide technological responses to this challenge. (Figure 1).

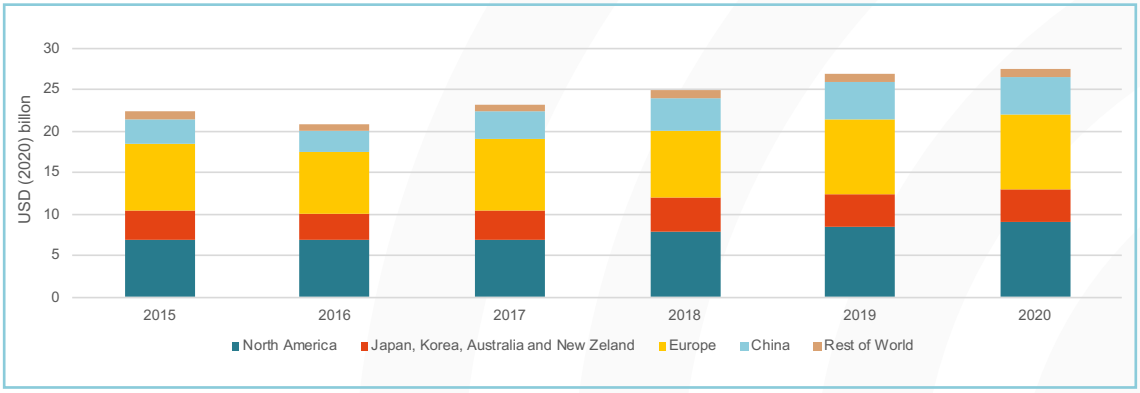

Figure 1. Public energy RD&D budgets for IEA members by regions 2015-2020 (billion USD (2020 prices and PPPs). Source: [7].

In Purchasing Power Parity (PPP) terms, the United States is the IEA member country that spent the most by far on energy R&D and innovation. It is followed by Japan, France, Germany, the UK, Canada, Korea, Italy, and Norway (Figure 2). On the other hand, Spain and Portugal spent the least. Figure 3 below shows Total RD&D in nominal national currencies divided by GDP in nominal national currencies at market prices and volumes, expressed in thousands units of GDP, among IEA member countries (this includes Brazil because it is an IEA association country). Data includes the European Union's energy RD&D budget under its Horizon 2020 programme. This ratio shows that the public budget varied widely among IEA member countries, ranging from 1.26 in Norway, the only country with a result higher than 1, to 0.02 in Mexico (a key EIA partner). Portugal and Spain lag far behind Norway, with ratios of 0.31 and 0.08 respectively.

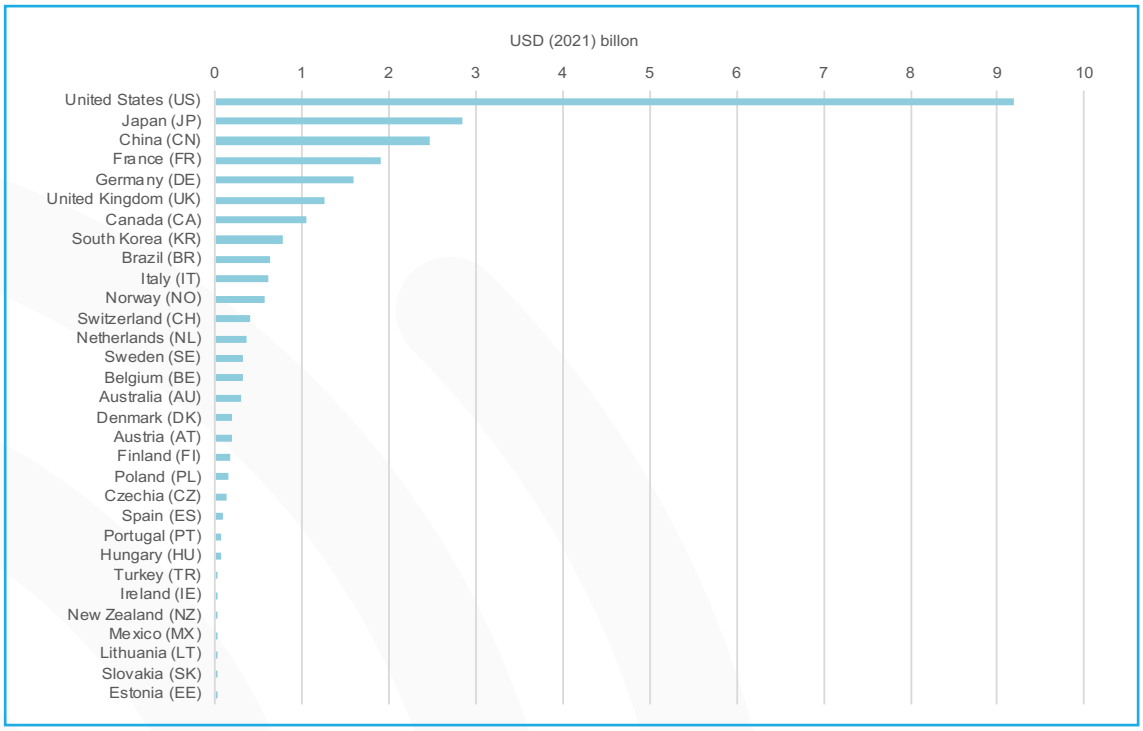

Figure 2. Total public energy RD&D budgets by country for 2021 or latest available year. Note: EU data corresponds to the budget of the H2020 programme. Source: [8].

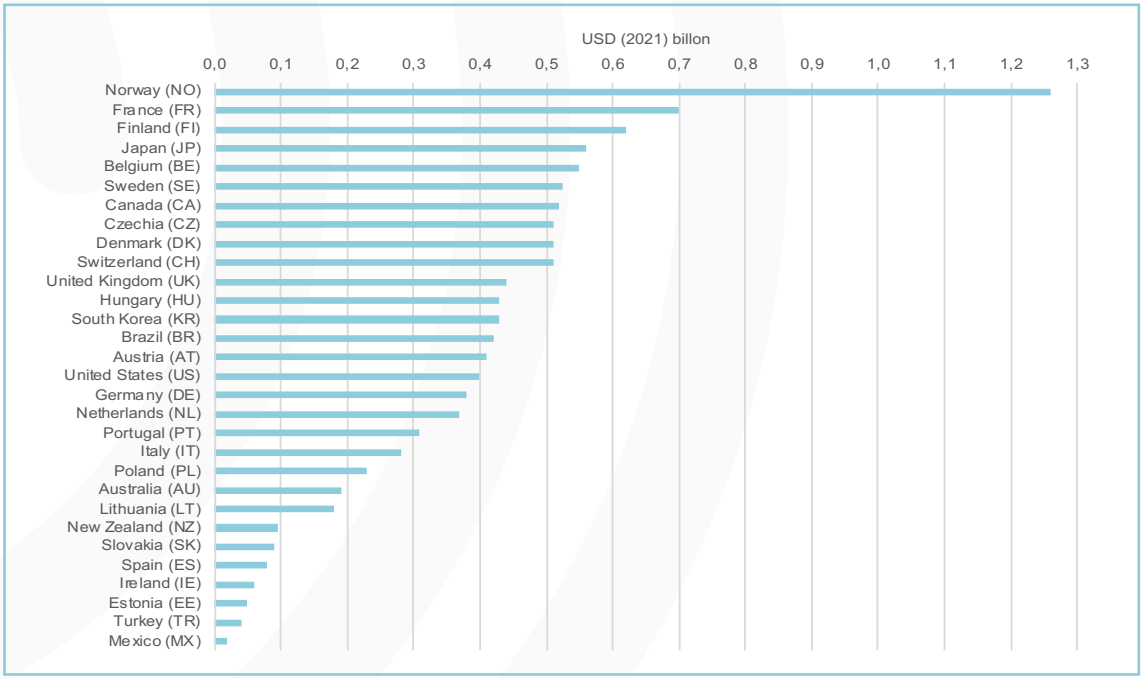

Figure 3. Total public energy RD&D budgets per thousand units of GDP by country for 2021. Note: EU data corresponds to the budget of the H2020 programme. Source: [9].

The progressive diversification of the energy R&D&I budget over the last 40 years among IEA member countries is remarkable. Nuclear power, which accounted for 75% of the total in 1974, declined every year, reaching 21% in 2020. RD&D budgets on fossil fuels, which were at their highest in the 1980s and early 1990s, have declined since 2013 (13%) arriving at 7% in 2020. Budgets for both energy efficiency and renewable energy sources increased significantly faster during the 1990s and 2000s, from 7% for both in 1990 to 23% and 21% respectively in 2010. Since then, the energy efficiency share has increased slightly to reach 26%, while the share of renewables has declined to 15%. Budgets for hydrogen and fuel cells remained relatively steady at 3% for the period 2012-2018, increasing to 4% in 2019 and 2020. Over the past five decades, the growing importance of spending on research and development is particularly evident in transversal projects (cross-cutting) that provide innovative solutions with low carbon emissions that lead to the reduction of emissions in multiple sectors such as through industrial symbiosis or business model innovation. Similarly, spending in new areas such as hydrogen or fuel cells is extremely relevant, which, although modest, already represent 3% of total public spending on RD&D.

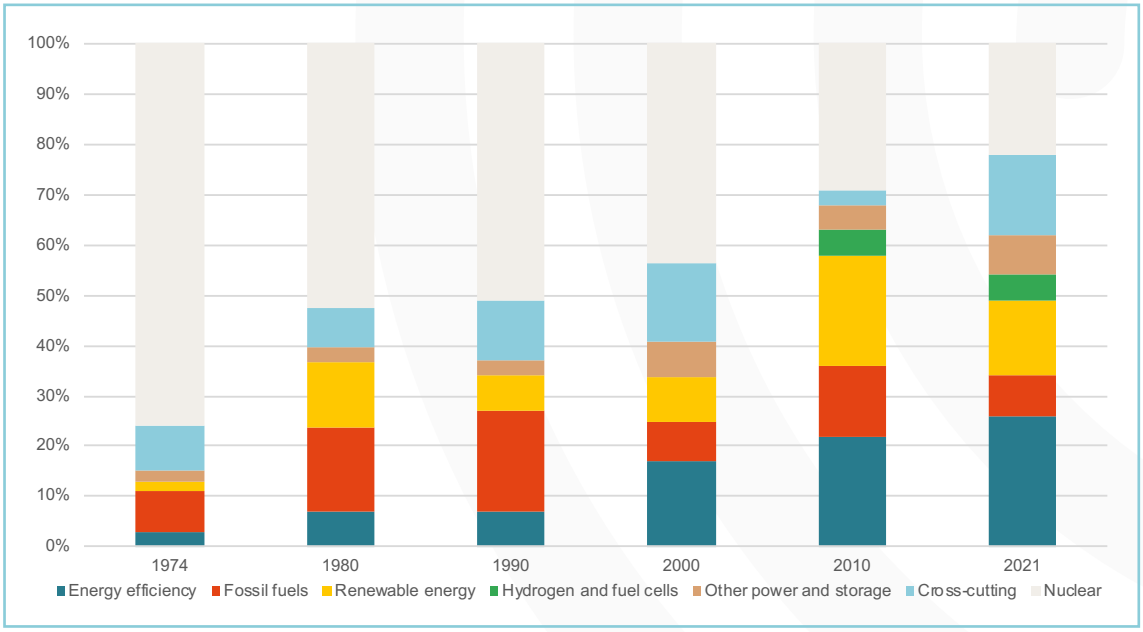

Figure 4. Evolution of IEA total public energy RD&D by technology, 1974-2020. Source: [10]

Figure 5 shows the change in budgets between 2019 and 2020 by technology. Overall, the increase in investment by the United States is notable. In 2020, the US spent the most in terms of RD&D on nuclear (USD 1.385 billion) followed by Japan. However, Japan remained by far the highest funder of hydrogen and fuel cell research (USD 318 million). In 2020, the European Union spent a fifth of its total RD&D budget on power and storage technologies (USD 428 million), spending more than any other region in this category. For all remaining technologies, the United States had the largest budgets. In 2020, the budget of IEA countries increased for all types of technology except for cross-cutting technologies, which decreased by 3%. The highest increase was 15% for hydrogen and fuel cells, which followed a 25% increase in 2019.

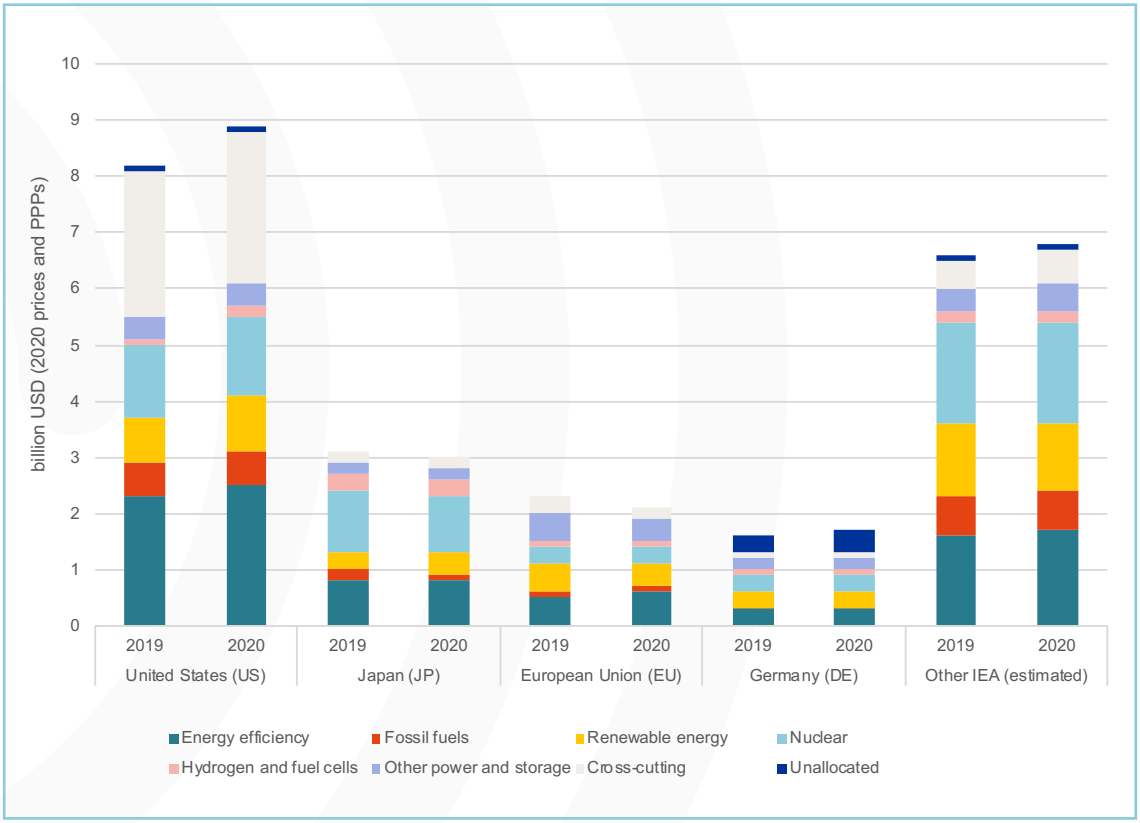

Figure 5. 2019 and 2020 budgets by technology in selected IEA countries and the European Union (billion USD (2020 prices and PPPs). Source: [11].

1.3 Strengths and weaknesses of the innovation systems in Spain, France, and Portugal

This section of the report addresses the strengths and weaknesses of the innovation systems of the three study countries in the Tr@nsNet project, based on the European Innovation Scoreboard, a report that has been published annually by the European Union since 2000 and which allows policy makers to identify the areas that they need to focus their efforts on in order to stimulate innovation performance. The Synthetic Innovation Index[1] is used to classify Member States into four groups: innovation leaders, strong innovators, moderate innovators, and emerging innovators with results well below the European Union average. In 2021, this indicator placed Spain and Portugal in an unfavourable position within the group of moderate innovators, which was below the European Union average. On the contrary, France is in the group of strong innovators and above the average of the European Union (Figure 6).

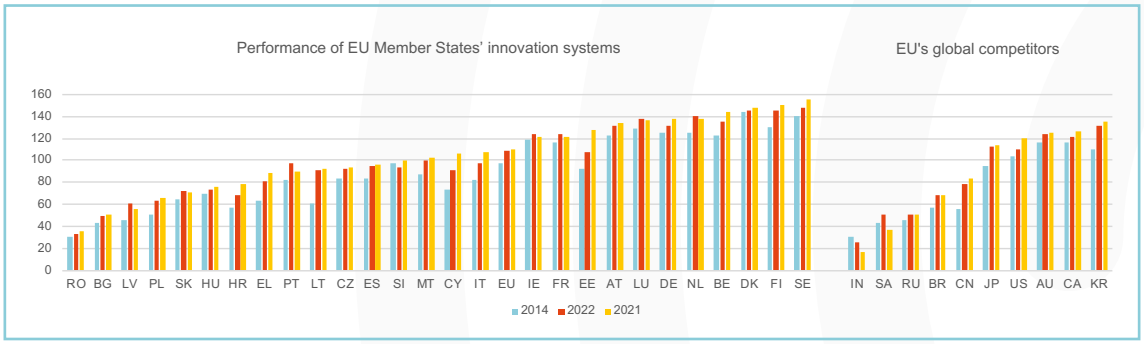

Figure 6. General results of the innovation systems of EU Member States. Source: [12].

Situation of Spain

As a country with moderate innovation, Spain is ranked 16th out of the total of 27 countries in the European Union in the innovation ranking. The diagnosis of the European Innovation Scoreboard shows that it needs to work on areas such as the promotion of product and process innovation in small and

1. The Synthetic Innovation Index distinguishes between four main types of activities: framework conditions, investments, innovation activities and impacts, and has 12 dimensions of innovation, covering a total of 32 indicators.

medium-sized companies, R&D spending in the business sector and the promotion of innovative SMEs that collaborate with other agents. On the other hand, it is above the European average in the terms of human capital, digitisation (broadband penetration sits at 30% higher, and people with general digital skills above basic is 23% higher) and sustainability environmental (productivity of natural resources is 59% higher). Regarding the adoption of cooperation strategies for innovation at company level, there are significant inequalities in the intensity of cooperation for innovation between the different Member States of the Union. The Nordic countries are the forerunners in this aspect, with high levels of cooperation, while the countries in the Iberian Peninsula along with Poland and Eastern Europe are at the bottom of the ranking. Another area of difference is sectoral, since it is observed that the electricity, gas, steam and air conditioning sector shows a greater propensity to cooperate with the agents of the innovative ecosystem.

STRENGTHS (Above the level of the EU-27)	WEAKNESSES (Below the level of the EU-27)
• Doctorate graduates	• Lifelong learning
• Population with tertiary education	• International scientific co-publications
• Broadband penetration	• Most cited publications
• People with above basic overall digital skills	• Foreign doctorate students
• Venture capital expenditures	• R&D expenditures in the public sector
• Enterprises providing ICT training	• Government support for business R&D
• Public-private co-publications	• R&D expenditure in the business sector
• Job-to-job mobility of HRST	• Non-R&D Innovation expenditure
• Trademark applications	• Innovation expenditure per employee
• Sales of innovative products	• Employed ICT specialists
• Resource productivity	• Product innovators (SMEs)
	• Business process innovators (SMEs)
	• Innovative SMEs collaborating with others
	• PCT patent applications
	• Design applications
	• Employment in knowledge-intensive activities
	• Employment in innovative enterprises
	• Medium- and high-tech goods exports
	• Knowledge-intensive services exports
	• Air emissions by fine particulate matter
	• Environment-related technologies

Table 1. Strengths and weaknesses of the Spanish innovation system in 2020 according to the European Innovation Scoreboard 2021. Source: [12].

Situation of France

France is a strong innovator and is ranked 10th out of the total of 27 countries in the European Union in the innovation ranking, although its relative performance has decreased. The strong innovative countries are the second group after the leaders, with Sweden in the lead. The results of the European Innovation Scoreboard shows that France is the country with the best performance in terms of financing, an indicator that includes private financing (venture capital investments), R&D expenditure in universities and government research organisations, government financing and support government tax to corporate R&D. The three most important indicators in the country are foreign doctoral students, lifelong training and government support for business R&D. The recent decline in innovation performance is mostly due to reduced sales of innovative products and technologies related to the environment. France has an above-average share of in-house product innovators with first-to-market and scores above-average on climate change-related indicators. However, the country shows deficiencies in terms of digitisation (level of digital technologies), level of intellectual assets and use of information technologies, placing it below the EU average.

STRENGTHS (Above the level of the EU-27)	WEAKNESSES (Below the level of the EU-27)
• Doctorate graduates	• International scientific co-publications
• Population with tertiary education	• Most cited publications
• Lifelong learning	• Broadband penetration
• Foreign doctorate students	• R&D expenditures in the public sector
• People with above basic overall digital skills	• R&D expenditure in the business sector
• Venture capital expenditures	• Non-R&D innovation expenditure
• Government support for business R&D	• Business process innovators (SMEs)
• Innovation expenditures per employee	• Trademark applications
• Employed ICT specialists	• Design applications
• Product innovators (SMEs)	• Knowledge-intensive services exports
• Innovative SMEs collaborating with others	• Sales of innovative products
• Public-private co-publications	• Environment-related technologies
• Job-to-job mobility of HRST	
• PCT patent applications	
• Employment in knowledge-intensive activities	
• Employment in innovative enterprises	
• Medium and high-tech goods exports	
• Air emissions by fine particulate matter	

Table 2. Strengths and weaknesses of the French innovation system in 2020 according to the European Innovation Scoreboard 2021. Source: [12].

Situation of Portugal

Portugal is ranked 19th out of the total of 27 countries in the European Union in the innovation ranking and is, therefore, a moderate innovator. In 2020, it reached its maximum historical performance, but in 2021 it dropped to a level below that of 2019. The country is strong in the use of research systems, digitalisation and the use of information technologies. The three indicators in which Portugal performed best are the number of foreign doctorates, international scientific co-publications, and HR mobility between jobs. Portugal is the country with the greatest decrease between the performance of the year 2020 and 2021. This is due to the reduction in the indicators used in the innovation survey, and so the large increases in results in tertiary education, government support to business R&D, ICT specialists, HRST job mobility and environmental related technologies are not immediately evident. Portugal has a below-average share of in-house business process innovators and non- self-developed innovations and shows below-average scores on climate change-related innovation indicators.

STRENGTHS (Above the level of the EU-27)	WEAKNESSES (Below the level of the EU-27)
• Doctorate graduates	• Population with tertiary education
• International scientific co-publications	• Lifelong learning
• Foreign doctorate students	• Most cited publications
• Broadband penetration	• R&D expenditures in the public sector
• People with above basic overall digital skills	• Venture capital expenditures
• Government support for business R&D	• R&D expenditure in the business sector
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	• Innovative SMEs collaborating with others
	• PCT patent applications
	• Design applications
	• Employment in knowledge-intensive activities
	• Employment in innovative enterprises
	• Medium and high-tech goods exports
	• Knowledge-intensive services exports
	• Resource productivity
	• Air emissions by fine particulate matter
	• Environment-related technologies

Table 3. Strengths and weaknesses of the Portuguese innovation system in 2020 according to the European Innovation Scoreboard 2021. Source: [12].

1.4 Open innovation trends and the situation of Living Labs in the Sudoe region

Open or collaborative innovation[2] proposes a new strategy for innovation that involves cooperation between companies, universities, suppliers, clients and other external talent to expand capacity to generate value beyond the limits of the organisation itself. It has become a key driver of innovation thanks to the promotion of the collaborative exchange of knowledge between various actors. The objectives of open innovation initiatives are broken down into several levels:

- Creation of new products or services to diversify the activity of an organisation or transform its business model.
- Integration of disruptive technologies in a business environment which allow industrial scaling of the solution.
- Acquisition of skills, incorporation of talents into the organisation and promotion of a cultural transformation.
- Contribution to an organisation's sustainability and impact strategy.

The methodology for developing an initiative for open innovation is used by companies, who use this strategy at different stages in the process, from detecting areas of opportunity all the way through to the final development of a specific innovation. The areas of opportunity outlined in the organisation's strategy are taken as a starting point. Each area of opportunity is usually separated into challenges in order to find solutions through different use cases, that is, ways of responding to the challenge. To solve the use cases, specific projects are activated and/or the search for specific external talent is put into action. Based on this, the specific mechanism for open innovation (incubation program, acceleration program, strategic alliance, etc.) is implemented.

2. To address the activities related to open innovation, a cross-cutting issue in solving the challenges of the energy transition, we took as a reference the study carried out by CTA (a partner in the Tr@nsNet project) "R&D Overview and Innovation Trends 2021" [13].

This consists of the most relevant collaboration model between the driving organisation and the various external agents that can add value to development. of the promoted initiative.

In recent years, open innovation has established itself as a necessary practice for companies, who understand that collaboration with other organisations is essential, and that talent takes many forms. For this reason, there are many energy companies in the Sudoe region that develop open innovation programs as a direct line to promote their business and are open to projects with actors from different fields: from start-ups and entrepreneurs to technology centres, universities and other entities.

Open innovation is already part of the strategic plan in large companies and represents another line of work, to which they dedicate specific funding, resources and specific teams. Energy companies understand that this is an opportunity that should not be missed and, above all, that the competition is not missing out on this opportunity either. Open innovation is understood to be a competitive advantage and a way to develop products and services efficiently. For this reason, most large companies already have defined programs and their own internal structure to promote these types of collaborations and continue working towards the energy transition that we find ourselves needing.

On the other hand, a fact that has fostered the development of open innovation and its professionalisation is the growth of the start-ups themselves, not only in quantity, but also in quality and size. They stand out for their high degree of specialisation and agility, which makes them extremely attractive to large companies for the different challenges they face in the framework of the energy transition. Similarly, the high degree of knowledge available at universities and technological centres is of great interest to companies for the development of both incremental and radical innovations.

Public administrations can also contribute to the energy transition process by facilitating the development of technological and business innovations,

etc. by other actors. Among the actions that can be performed, the most important is that they act as a catalyst for initiatives and facilitator of collaboration between the rest of the agents involved. In this sense, it is vital that a stable, but at the same time flexible, legislative framework that facilitates the work of the agents that make up the innovation ecosystem is established. An example of this is facilitating testing the proposed innovations in controlled environments, such as *Sandboxes* and *Living Labs*.

Multiple reports from leading entities in the sector (International Energy Agency, European Commission, International Renewable Energy Agency, etc.) emphasize the urgent need to develop new products that make it possible to meet the objectives stipulated in the Paris Agreement. In this context, collaboration between the different entities is seen to be essential for improving existing infrastructures and technologies, taking advantage of the potential of digitisation and developing new clean technologies, which mean that an energy system that is fundamentally decarbonized and based on renewable energy sources can be achieved.

The evolution of collaborative innovation in the energy sector

The speed at which changes are happening in the energy sector has increased significantly in recent years. Various technological alternatives to conventional energy sources have been consolidated, society has become more aware of climate change (the energy sector being one of the main sources of greenhouse gas (GHG) emissions) as well as the need to mitigate its effects and has significantly increased the demand for energy worldwide, with the exception of 2020 due to the pandemic. In addition to others such as the depletion of conventional energy resources like coal, oil, natural gas, etc., these factors can be used to explain why we are currently in an energy transition process to achieve a more decarbonised, distributed and digitized energy system and in which access to energy and its different forms (such as electricity, etc.) is possible for the inhabitants in different parts of the planet.

However, despite the fact that the energy system is in full transition, the pace at which it is changing is insufficient to meet the objectives set at a global

level. Not only do existing clean technologies need to be deployed far beyond the scope at which they are currently being deployed, but new solutions also need to be developed. That is why innovation is one of the pillars of the energy transition. And it should be noted that these solutions must be generated quickly, meaning that collaborative innovation activities are essential.

As a result of this context, it is observed how large companies have made changes to their innovation models, moving from an internal or closed innovation system to an open innovation model or even shared innovation one. This is a strategic change that affects the management of R&D activities. Obviously, the model does not go from one extreme to the other, since there are areas in which corporations prefer to keep the innovation process within the company or limit collaboration with external entities to specific aspects for strategic reasons. What is currently observed is that practically all Corporations in the sector have tools focused on collaborating with external agents, since they are increasingly aware of the need and opportunity to integrate abundant knowledge that exists outside the boundaries of their organisation into their internal R&D activities. There is also a tendency among companies in the sector to share innovation programs with key players in the ecosystem. Collaborative innovation in a resource as basic as energy has some peculiarities that should be taken into account when understanding how this sector works and how it can influence the development of projects and initiatives.

The main challenge faced by collaborative innovation initiatives in this area is the intensity of resources imposed by the sector itself. Normally, the investments to develop projects are high and require a guarantee of financing and return that means that the initiatives have to offer safe alternatives.

This problem of scalability of innovations requires large amounts of investment and a boost that start-ups or spin-offs often cannot deal with on their own. It is at this moment when they need to be helped and guided by corporations in order for projects to be developed. Although it follows the form of a traditional relationship of open innovation, in the energy sector it becomes

more relevant: start-ups contribute ideas, agility and innovation and corporations provide financial support and use their structure to bring projects to a successful conclusion. In this sense, public support is also important for this first impulse, which allows the smallest agents to enter the market for the first time.

Another of the challenges faced by collaborative innovation in this sector involves the technological integration of solutions. Cutting-edge technological innovations or those with great potential face a reality in which current technologies are consolidated and find it difficult to incorporate new processes. Within this framework, the opportunities of energy as a service become evident and new players emerge, such as integration companies, which offer the precise solution for connecting existing technologies and innovations. These opportunities are accentuated due to the need to develop the technological solutions that are required within the framework of the energy transition towards a more efficient, clean and decarbonized system. Thus, many opportunities based on the integration of renewable energy sources into the electricity grid emerge. This is because maintaining the flexibility of the system and guaranteeing a safe, reliable and quality electricity supply is essential.

In this process of transforming the innovation ecosystem with new technological challenges, new energy and environmental challenges to respond to and new actors, digitisation can be seen as a catalyst for change. Digitisation contributes to achieving greater and more effective interaction and coordination between the different actors, increasing the level of information on the different systems and components, developing tools that improve the flexibility of the energy system, etc. Technological innovations in this area are ongoing, focusing on understanding customer behaviour, team performance or market fluctuations. The challenge faced by small agents trying to introduce their services in the market is competition from large technology companies with a long history and a large number of available resources. However, unlike what is considered the norm in the energy sector, the growing importance of digitisation means that the amounts required for investment are not very large on many occasions if solutions based on digital environments

are developed. On the other hand, until now digitisation has not been a main line of business for companies in the energy sector, although they are already fully aware of its growing importance and are including it among their priorities for innovation.

Finally, an element to take into account in the coming years is the commitment of the European Union to the energy transition, which is evident in a package of unprecedented legislative measures, as seen in the European Green Pact, the recent REPOWER communication and a disbursement of recovery funds that lay its foundations in the energy transition. Therefore, given the pressing need to develop innovations of a different nature (technological, business, etc.) that will accelerate the energy transition, it is expected that the different collaborative innovation mechanisms will favour the appearance and implementation in the market of the required technological solutions by sector.

STATE OF INNOVATION AT A MICRO SCALE

Dealing with the energy transition and facing the challenge of climate change requires technological, social, and organisational innovations. In terms of technological innovations, we need to find solutions to the challenges in the energy sector by strengthening the network, working towards green hydrogen, improving energy storage or sector coupling. Social innovations are needed to promote the participation of citizens, companies and administrations as new agents that not only consume energy but also generate, store or share it. And organisational innovations need to reflect that companies in the sector must adapt their business models to the energy system of the future, one that is decarbonized, decentralized, digitized and democratized, and understand the role that innovation plays in this entire process. In this context, and based on the knowledge of the global situation described in the previous section, we conducted a study to find out how the different public and private organisations are facing innovation within the framework of the energy transition. The next section describes the methodology used in the study and presents the main results. The specific results in terms of innovation management and scope, the impact of energy policy in the context of the NECPs, and the innovation financing mechanisms followed by the organisations are then presented.

2.1 Methodology for the study

To analyse the enablers of innovation in organisations, within the framework of the energy transition, an online survey (see Annex II: Innovation Survey) was administered in public and private organisations in Spain, France and Portugal between September 2021 and March 2022. The aim of the survey was to analyse the impact of energy policy in four key aspects: technological and social innovation, regulatory barriers and the use of activities related to open innovation.

As mentioned above, the NECPs become extremely relevant as a planning

tool in order for each Member State to meet its goals and objectives, guaranteeing the coherence, comparability and transparency of the information presented to the Framework Convention on Nations Convention on Climate Change (UNFCCC) and the Paris Agreement. It is a key tool in the current governance model of energy and climate policy at the community level, but also important for all the actors that are part of the innovation ecosystem, to the extent that it identifies the challenges and opportunities throughout of the five dimensions of the Energy Union: decarbonisation, including renewable energy; energy efficiency; energy security; the internal energy market and research, innovation and competitiveness.

For all these reasons, it was necessary to evaluate innovation policies at the microeconomic level, trying to identify how they had been affected, if at all, by the approval of the different NECPs.

The survey included questions about the situation before and after the publication of the NECPs in the three countries; specifically, for innovation activities that involve the creation of new goods and services and business models, for financing and collaboration activities with other organisations, on knowledge flows and on the relevance of R&D.

Figure 7 shows the methodology followed to address innovation strategies in the three study countries before and after the publication of the NECPs. The first section of this figure conceptually describes the methodology followed, and the second presents the algorithm implemented in the series of questions that the respondents were asked. The complete questionnaire that was used in included in Appendix 1. In the initial part of the survey, the purpose of the survey was explained and it defined the concepts in the field of innovation that are mentioned. The questions served to characterise the respondents. Then, respondents answered questions which focused on the management and scope of R&D in their organisations. Finally, the respondents were segmented in order to identify the organisations that had an innovation strategy prior to the publication of the NECPs and those that had established it afterwards. Both segments were asked a series of ques-

tions about innovation, and the segment that had a strategy before the NECP was asked about the influence this plan had had on their innovation strategy. Finally, both segments were asked for an open opinion on the NECPs.

Due to the nature of the survey, attempts were made to understand the factors that explain the entire innovation framework of organisations, paying special attention to the impact of energy policy through the NECPs on their strategies for linking with the market challenges related to the energy transition. In terms of R+D+i, we aimed to find out about how the process of investing in research and the use of open innovation can lead to knowledge that is developed to achieve mostly economic benefits through products and services in the market, which are the fruits of technological innovation. Addressing the innovative process of technology (understood as the creation of a new or significantly improved product or process, including new or improved techniques, components, materials or software) in this study also had the potential to further understanding of the social nature of innovation when related to the creation of new ideas for services or business models that satisfy social needs and simultaneously create new collaborative relationships in society.

In addition, when studying the enablers of innovation in the energy transition, attempts were made to address the regulatory contexts in which technological and social innovations are developed. For this reason, the regulatory barriers that organisations find to launch them to the market are investigated. The regulatory innovations arising from the entities that promote them must be in line with technological and social innovations in order to facilitate the entry into the market of new products, services or business models, while at the same time protecting the interests of consumers [14]. By addressing technological and social innovation, the use of open innovation and the context of regulatory innovation in this way, we are one step closer to understanding how organisational strategies and financing mechanisms for getting innovations to market to provide better products and services to consumers are managed.

A. Conceptual scheme of the surveys conducted:

PREVIOUS SITUATION ON:	NATIONAL ENERGY AND CLIMATE PLANS (NECPS)	SUBSEQUENT SITUATION ON:
• Technological Innovation • Social Innovation • Open Innovation Activities • Regulatory Barriers	**France:** Plan National Integre Energie-Climat, January 2020 **Portugal:** Plano Nacional Energia e Clima 2021-2030, December 2019 **Spain:** Plan Nacional Integrado de Energía y Clima (PNIEC) 2021-2030, January 2020	• Technological Innovation • Social Innovation • Open Innovation Activities • Regulatory Barriers

B. Sequential structure of the surveys conducted:

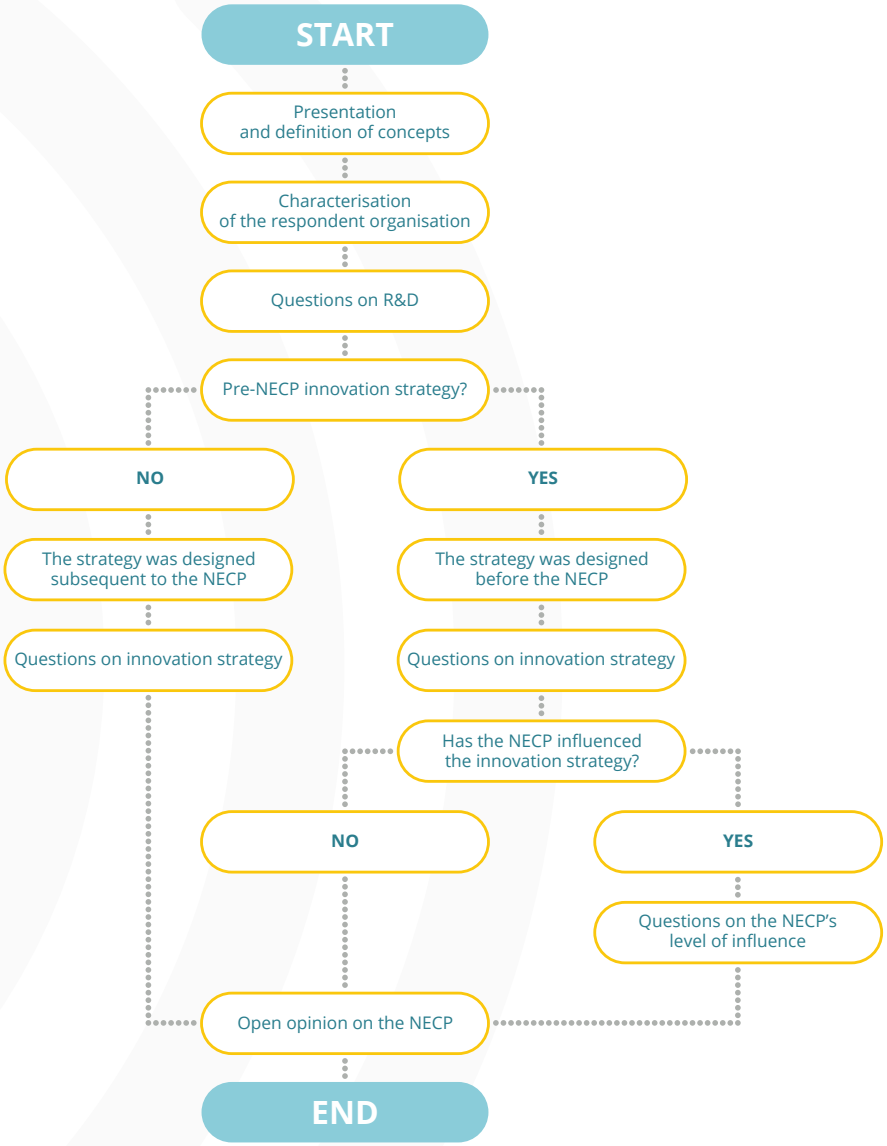

Figure 7. Methodology followed to find out the situation of organisations in terms of technological and social innovation, use of open innovation and the context of regulatory barriers with the publication of NECPs. Source: Own elaboration.

2.2 Overall results

The results of the research reflect that the organisations of the Sudoe region have innovation strategies linked to the challenges of the energy transition, and in line with the energy policy reflected in the NECPs. In these strategies, environmental protection prevails, and they place the consumer in the central axis of decarbonisation. The organisations have responded to the questions at a time very close to the publication of the NECPs, which is why it is too soon to make claims as to the effectiveness of the energy policy on the economic growth of those surveyed. However, managing to segment the protagonists of innovation between two groups of organisations with innovation strategies designed before and after the NECPs is already an important advance for data collection that hints at market signals in terms of barriers to innovation. The fact that firm foundations have been laid to consolidate the trajectory of climate neutrality for the economy and society by 2050 has been a decisive element for these companies in reinforcing their innovation strategy in the energy and climate field. Barriers to innovation are not new, but one of the objectives of the NECPs has been to facilitate the arrival of innovations to the market in order to face energy and climate challenges. In fact, the differences in the conditions of each national framework affect the propensity of companies to cooperate [15]. Therefore, the results of this study are a starting point to further compare how NECPs have influenced organisations with more robust innovation strategies and better connected with the environment through open innovation.

Table 4 summarizes the comparative results between the two segments of organisations identified: those that had an innovation strategy prior to the NECP and those that designed it after the publication of the Plan. More than a third of all these organisations (53% large companies and the remaining 47% medium, small and micro companies in similar proportions[3]) have implemented fruitful sustainability strategies with which they have managed to introduce goods or services that are either new or significantly better or sensitively

3. Most of the responses to the surveys (81%) were provided by a manager or manager of the organisation's innovation area.

adapted to the market. In these organisations, open innovation activities have played a prominent role and technological and social innovations have been important ways to seek growth in the market. Among the barriers that have hindered further growth in the market for the innovations from these organisations are access to public financing, the uncertainty that innovations will achieve success in the market, and the cost of innovation activities.

Designed innovation strategy:	Prior to NECP	Post-NECP
Ranking of the objectives in the innovation strategy of organisations	1. Create value for the customer 2. Reduce negative social or environmental impact 3. Access new markets 4. Increase market share 5. Reduce production costs	1. Create value for the customer 2. Increase market share 3. Access new markets 4. Reduce negative social or environmental impact 5. Reduce production costs
Has introduced new or significantly improved goods or services to the market	Yes: 93.5% No: 6.5%	Yes: 47.1% No: 52.9%
Responsibility in the development of innovations	53% indicated that the organisation was in cooperation with other organisations	56% indicated that the organisation in cooperation with other organisations
Meeting expectations regarding product innovations	36% indicated that expectations were met	47% indicated that it is too early to assess the results
Activities related to technological and social innovation	R&D activities in general are most evident	Activities related to the circular economy stand out
Activities related to the use of open innovation	Activities related to market research stand out	R&D activities in general stand out
Degree of affectation of the regulatory barriers found	31% indicated a very high level of affectation	34% highlighted a medium level of involvement
Financing of technological and social innovation	31% indicated that this is done with funds from local administrations (excluding public procurement)	34% indicated that this is done with research and innovation funds from the European Union (excluding public procurement)
Funding the use of open innovation	31% indicated that this is done with research and innovation funds from the European Union (excluding public procurement)	43% indicated that this is done with research and innovation funds from the European Union (excluding public procurement)

Designed innovation strategy:	Prior to NECP	Post-NECP
Ranking of barriers to technological innovation	1. Cost of innovation activities 2. Difficulties in accessing public funding 3. Uncertainty due to the demand for innovations in the market	1. Difficulties in accessing private financing 2. Difficulties in accessing public funding 3. Costs of innovation activities
Ranking of barriers to social innovation	1. Difficulties in accessing public funding 2. There are other priorities in the organisation 3. Cost of innovation activities	1. Difficulties in accessing private financing 2. Lack of partners for collaboration 3. Lack of qualified personnel within the organisation
Ranking of barriers to the use of open innovation	1. Cost of innovation activities 2. Uncertainty due to the demand for innovations in the market 3. Too much competition in the market	1. Difficulties in accessing private financing 2. Difficulties in accessing public funding 3. Costs of innovation activities

Table 4. Summary of the impact of NECPs on the organisation's innovation strategy. Source: Own elaboration.

2.3 Innovation management and scope

To understand innovation processes, it is necessary to first understand how it is managed at a corporate level. The different innovation management models condition the potential results. Within the framework of the cooperation that is sought between the agents to jointly address the challenges of the energy transition with innovations in the market, open innovation models are a priority and have allowed organisations to manage collaboration with people and entities external to the company, expanding research and development to external knowledge silos. In this study, by using several questions about the management and scope of innovation we aim to discover what the relationship of organisations with their environments is like in addition to the usual agents: suppliers, employees and customers. In this sense, the priority was to find out to what extent the organisations sur-

veyed have relied on cooperation with other organisations or groups of organisations to create, adapt or modify goods or services, or goods and services originally developed by other organisations. Similarly, we were interested in finding out about the relationship between the agents in the three countries of the Sudoe region that were the focus of the study (Spain, France and Portugal) and between this market and that of other countries of the European Union or outside of it. The main results are presented below.

Almost half of the organisations surveyed manage R+D+i from within a specific department that has been created for that purpose. Planning is done transversally in all departments, defining a vision, monitoring progress, budget and resources, as well as identifying external partners and communicating the innovation plan. Other respondents reported having decentralized R+D+i management mechanisms in each department, and some reported that it was managed in different ways depending on the projects being carried out in order to connect directly with customer requirements. All those surveyed reported that, from 2019 to 2020, they increased the percentage of turnover allocated to R+D+i. Although around 50% allocated less than 5% of their turnover to R&D, the percentage of organisations that allocated more than 20% increased from 29% to 32.3% between 2019 and 2020. The following figure describes the data in detail.

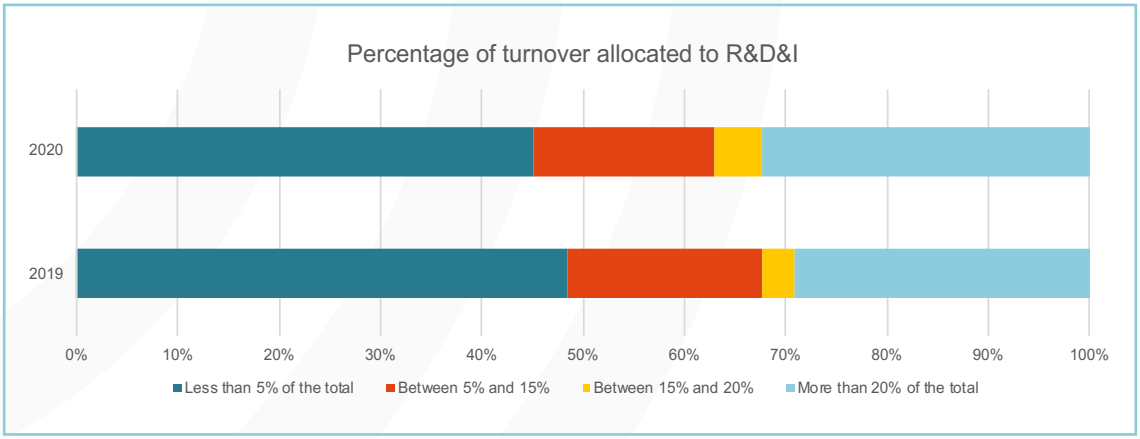

Figure 8. Percentage of billing allocated to R&D&I by the organisations surveyed. Source: Own elaboration.

Of the organisations surveyed 57% carry out exchanges of intellectual and technological property with partners from other countries, either through joint research projects, purchase and sale of patents, use licenses or royalty assignment contracts, or through other intermediary organisations or platforms. It was found that 89% of the organisations surveyed participate in national or European projects with external funding. In terms of collaboration, 55% reported carrying out projects with partners from countries in the Sudoe region and 45% with other countries, of which 29% were countries of the European Union and 16% with countries outside the European Union.

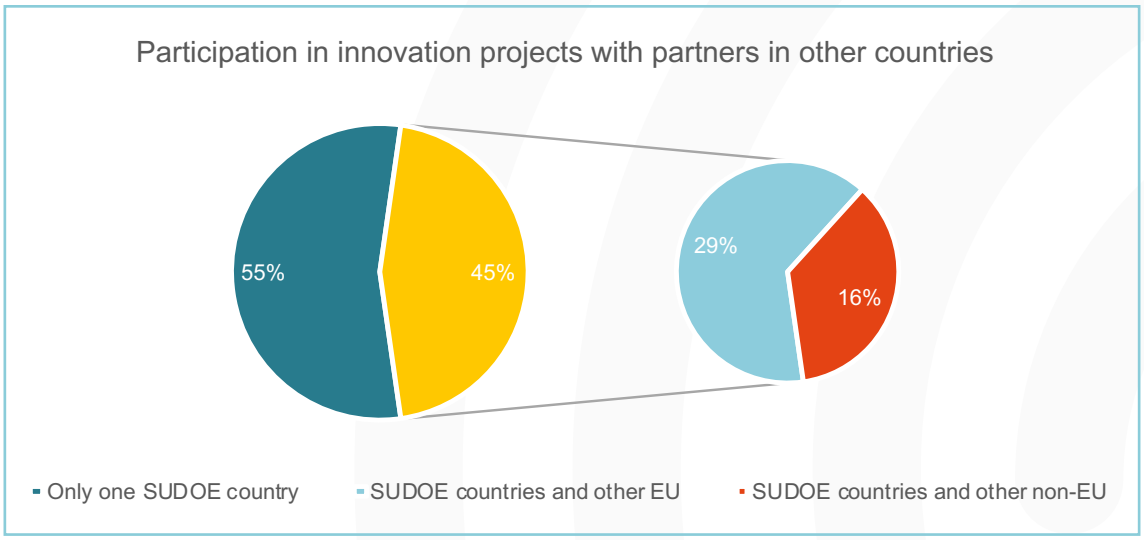

Figure 9. Participation of the surveyed organisations in innovation projects with partners from other countries. Source: Own elaboration.

Most of the organisations surveyed (74.6%) have a strategy or general rules to participate in innovation projects with external organisations. To do this, they use memorandums of understanding, agreements or similar with public and/or private companies. In addition to the specific strategy to reach the public or private sector, the results of R&D apart from innovation, such as the transfer of patents, the organisations surveyed reported having mechanisms through a commercial network or linking offices of technology transfer, or through the transfer of results with conditions of use, or with the creation of new technology-based companies when the innovation becomes Deep Tech.

Beyond the multiple motives that drive companies to cooperate, an important finding of recent contributions is that innovation success and overall performance is influenced by the nature of cooperation partners. In this sense, these organisations prioritize establishing R&D cooperation with other types of organisations with this order of importance: private companies, research centres, universities and start-ups. In terms of open innovation and to promote the connection with other agents, 35.2% of the organisations reported having promoted actions such as exploration missions, hackathons (a design sprint-type event in which ICT developers collaborate intensively on software development projects), challenge awards, corporate venture capital provision, acceleration, incubators (designed to support start-ups from the beginning with ideation to completion), or corporate incubators (similar to accelerators, typically with three months support for start-ups), strategic association, or the action of sharing resources for R&D.

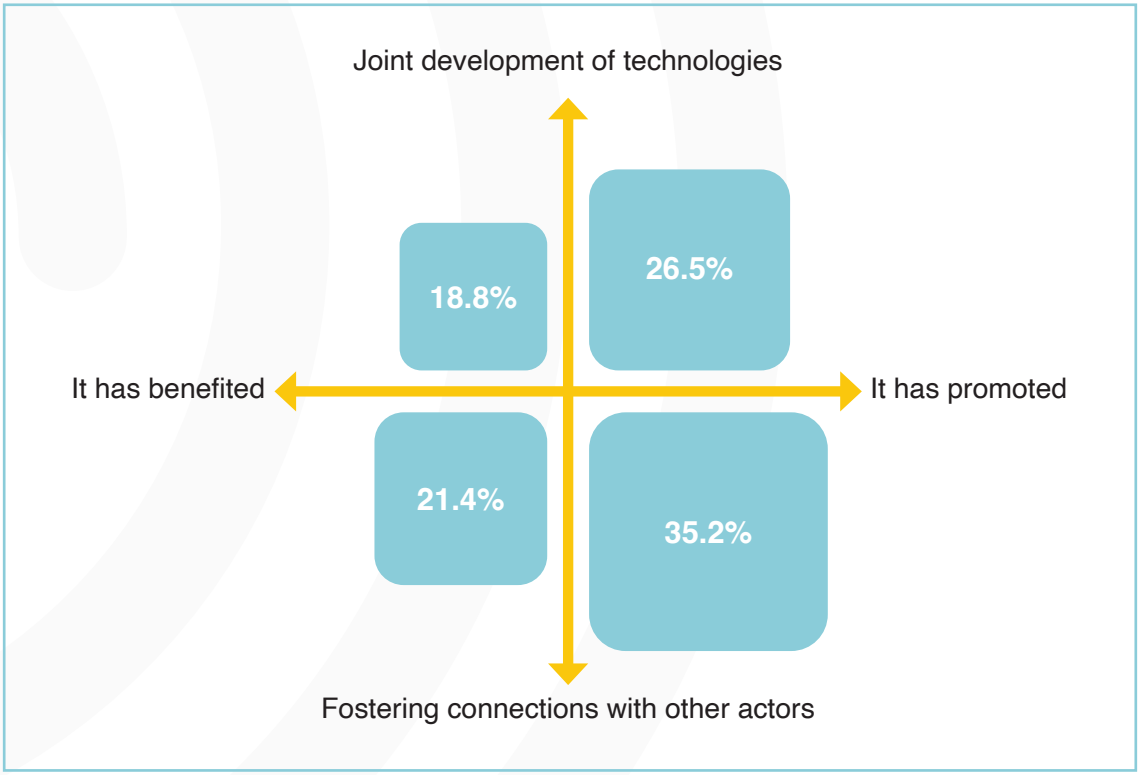

Figure 10. Actions linked to open innovation carried out by the organisations surveyed. Source: Own elaboration.

2.4 The impact of energy policy on innovation

In the European Union, energy policy has the objective of driving the production, distribution and consumption of energy towards economic growth and environmental sustainability. But this policy has drawbacks, such as dependence on energy imports, limited diversification, high and volatile energy prices, economics in the international environment, and growing threats from climate change. Given the progress already achieved, the challenges range from the slow progress made in energy efficiency to the challenges posed by increasing the share of renewable energy, as well as the need for greater transparency and better integration and interconnection of energy markets [16]. The core of European energy policy is made up of a series of measures aimed at achieving an integrated energy market, security of energy supply and sustainability of the sector. With the emergence of the NECPs, an economic, social, environmental and public health impact of the Union is sought. This involves the mobilisation of billions of euros in investments to trigger an expansive effect on the economy, the increase in gross domestic product (GDP), the growth of the energy saving and efficiency trend, and the change in the energy mix, which would reduce the importation of fossil fuels. Similarly, included in the expected impacts of the NECPs measures are the generation of employment and greater robustness of the industrial environment of renewable energies [17]. This will all be thanks to the strengthening of innovation. The results obtained in the study are described below.

It was found that 73% of the organisations surveyed had an innovation strategy prior to the publication of the NECPs in their country. The priority of this strategy was to create value for customers and reduce the negative social or environmental impact of the organisation. The following figure presents the other priorities considered.

Figure 11. Ranking of the objectives of the innovation strategy in the organisations surveyed. Source: Own elaboration.

More than 90% of these organisations reported having succeeded in introducing new or significantly improved goods or services to the market with this innovation strategy. Regarding goods or services that were only new for the organisation, the turnover increased in the ranges between 5% and 15% and more than 20%, from 2019 to 2020. In terms of goods and services without alter or slightly modified (including products completely developed and produced by others), the turnover increased in the ranges less than 5%, between 15% and 20% and more than 20%. With respect to new or significantly improved goods and services that, in addition to being new for the organisation, were also new for its market, turnover increased in the ranges of less than 5%, between 5% and 15%, and between 15% and 20%.

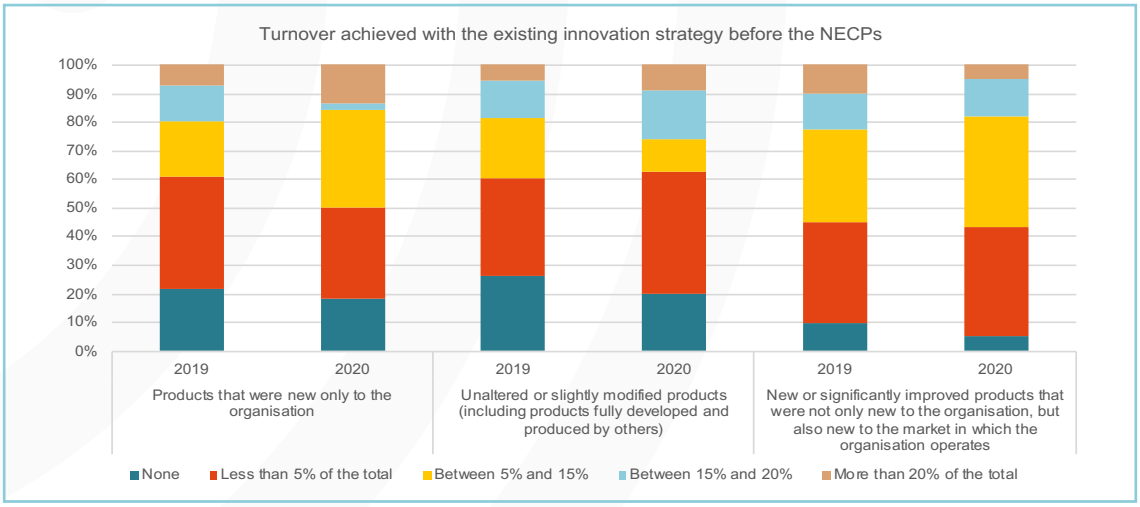

Figure 12. Business volume achieved in the surveyed organisations with the existing innovation strategy before the NECPs. Source: Own elaboration.

In the survey, 53% of these organisations reported developing the goods and service innovations they brought to market in cooperation with other organisations, 21% reported that they themselves were responsible for the development. More than 50% responded that the expectations regarding the innovations achieved in 2019 were not met, and regarding those of 2020, that it is too early to assess the results.

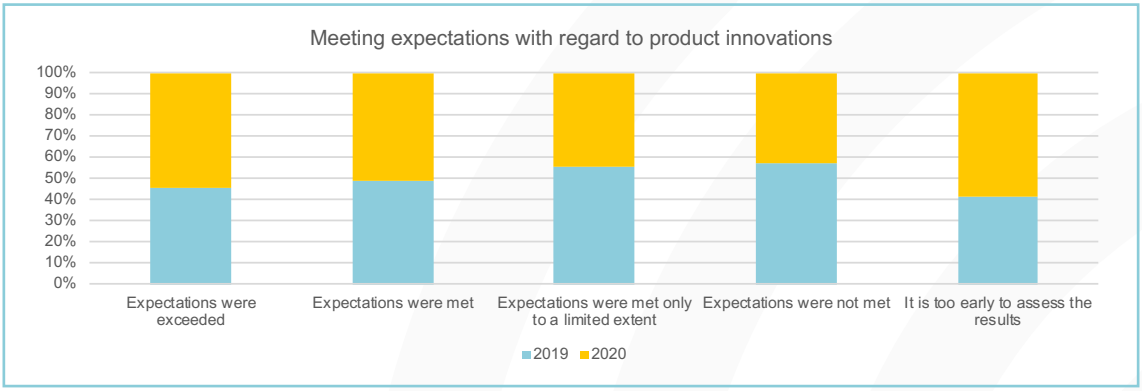

Figure 13. Fulfilment of expectations regarding product innovation by the organisations surveyed. Source: Own elaboration.

Based on their innovation strategy, which existed before the launch of the NECPs in their country, 11.11% of these organisations carried out activities related to technological and social innovation that were closed at the end of 2019 and general R&D activities. Regarding activities related to open innovation, they mainly carried out activities with market research and marketing for the products or services resulting from the innovation. These organisations reported having found regulatory barriers to innovations due to the absence of regulation, or incomplete regulation, in some of their fields of operation. They reported the difficulty they faced by not having a regulatory framework of regulatory test benches in the energy sector (energy sandboxes) as well as disincentives to innovation due to lack of aid in regulated companies or limitations in the creation of sectoral and intersectoral synergies between regulated and non-regulated companies within the same group. They also reported the absence of concrete regulation in the development of hydrogen and energy communities. But on the whole, the regulatory barriers were mentioned in relation to the development and ap-

plication of new technological solutions due to the use of the latest generation enabling technologies. Furthermore, regulatory barriers to innovations due to regulation in the field of emissions management are reported. In fact, 31% of respondents were affected to a high degree by these regulatory barriers.

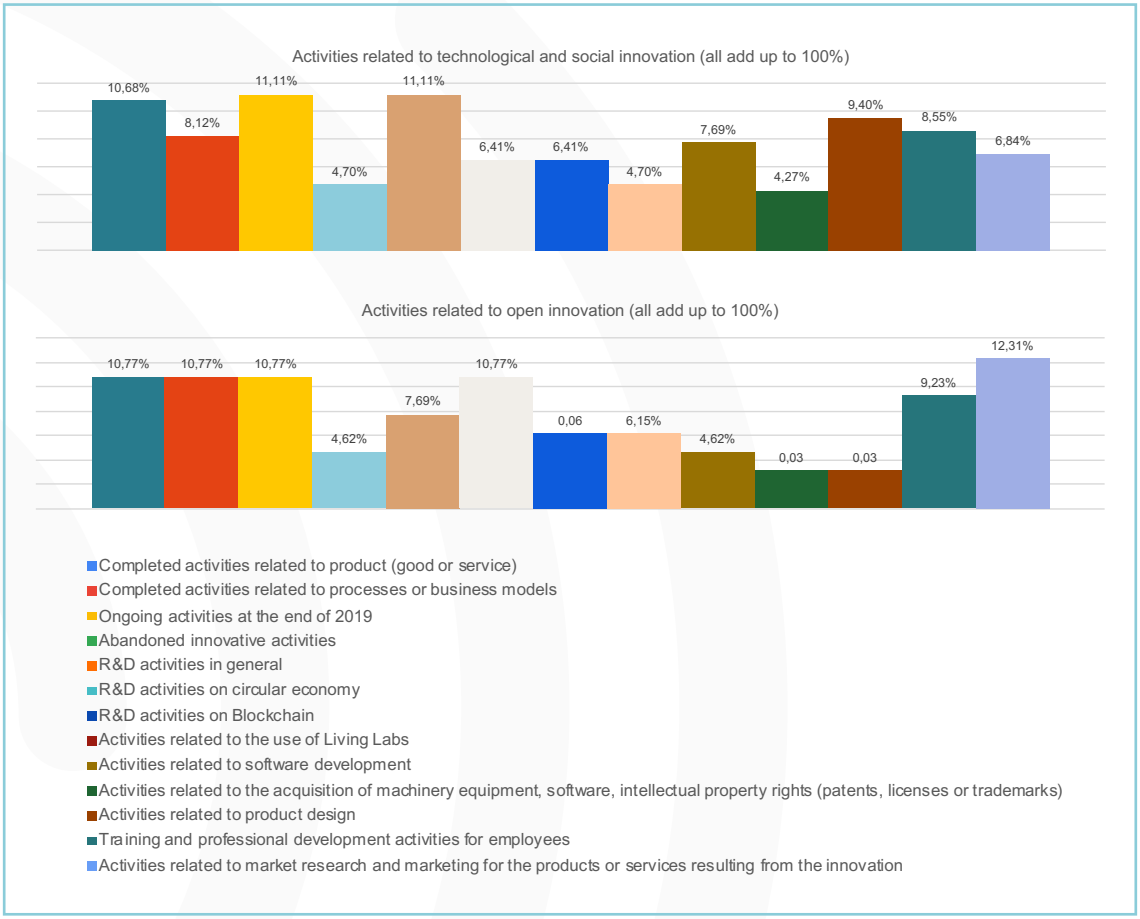

Figure 14. Activities related to technological and social innovation, as well as activities related to open innovation, carried out by the surveyed organisations with an innovation strategy prior to the NECPs. Source: Own elaboration.

2.5 Importance of financing innovation

In the existing economic literature, access routes to financing have traditionally been identified as a barrier to innovation, especially in those production

networks in which most companies are characterized by their limited size.

Lack of finance, or difficulties in accessing it, has been a major barrier to economic development. In all economies, the difficulties that smaller companies have to access financial resources condition their capacity for economic growth and competitiveness in foreign markets. Therefore, adequate financing is needed to help boost growth and employment, especially from the perspective of innovation.

In the specific case of the relationship between innovation processes and business size, it should be noted that SMEs face greater problems given the high cost of innovation and the uncertainty about possible success in the market. As the Interreg Sudoe program mentions, the regions of southwestern Europe have similar problems: low investment in research and development, limited competitiveness of small and medium-sized companies, and exposure to climate change and environmental risks. To solve this problem, the European Union considers that the most efficient way to solve these challenges is to work together, combining efforts and overcoming national barriers between innovative agents with the aim of coming up with the best ideas, sharing good practices and avoiding duplicating work. For this reason, this study included an additional focus of finding out how the innovative agents of the Sudoe region perceive the financing of innovation [18] . The results will make it possible to refocus the process and encourage public and private entities to create a support network for innovators.

The organisations surveyed stated that they rely on tax credits or deductions, grants, subsidized loans and loan guarantees for the development of technological and social innovations and for the use of open innovation. In the specific case of the development of technological and social innovation, 31% reported that this support comes from local Administrations (excluding public procurement); and in the case of open innovation, for 31%, this support comes from the Horizon 2020 program for Research and Innovation of the European Union (excluding public procurement).

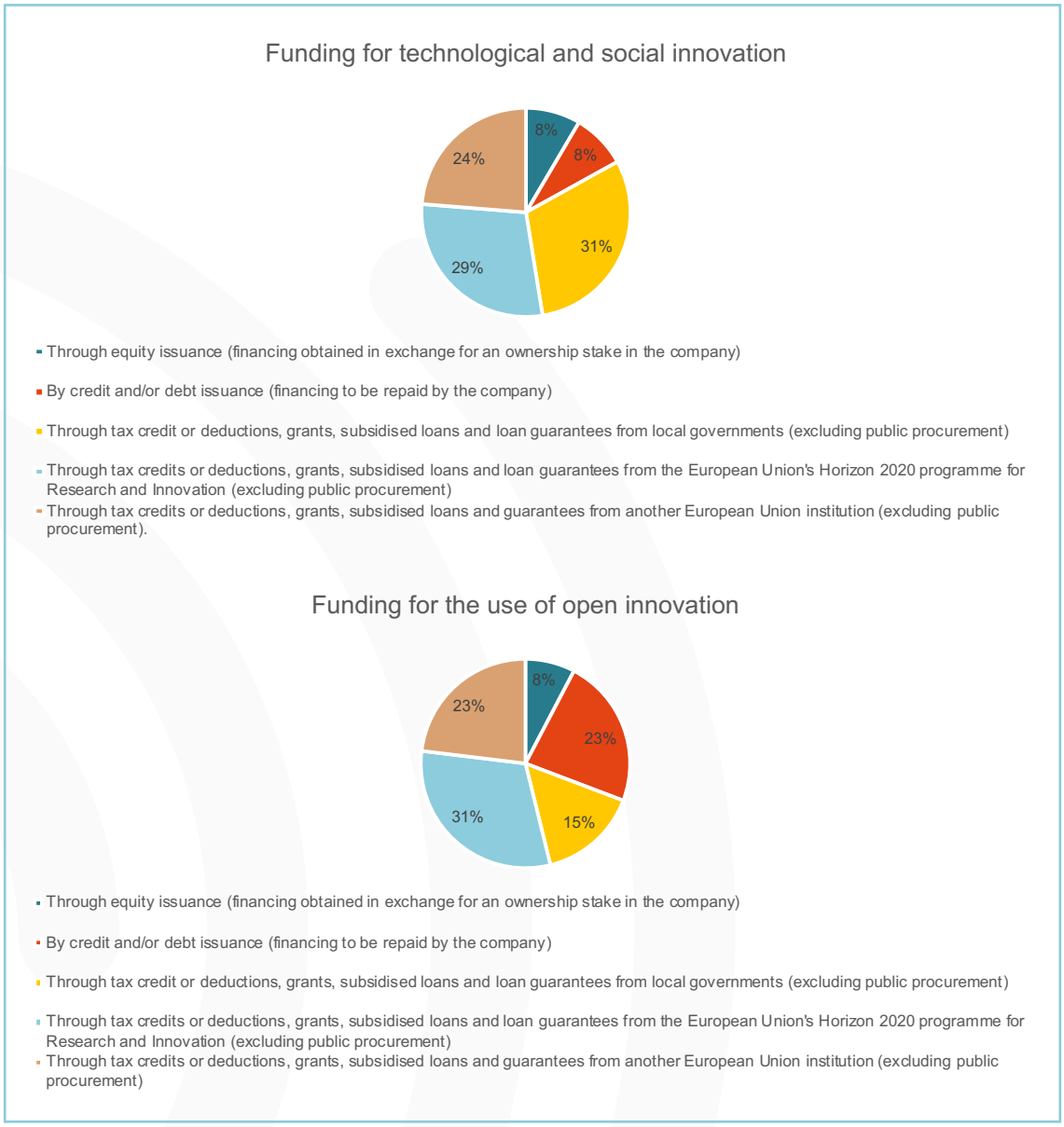

Figure 15. Origin of the financing of technological and social innovation and of the open innovation activities of the organisations surveyed. Source: Own elaboration.

The organisations surveyed reported that prior to the publication of the NECPs in their countries they found barriers in their technological innovation strategy, mainly due to the cost of the activities and the difficulties in accessing public financing. In the case of social innovation, the problem was the difficulty in accessing public funding and in open innovation, it was the cost of the activities.

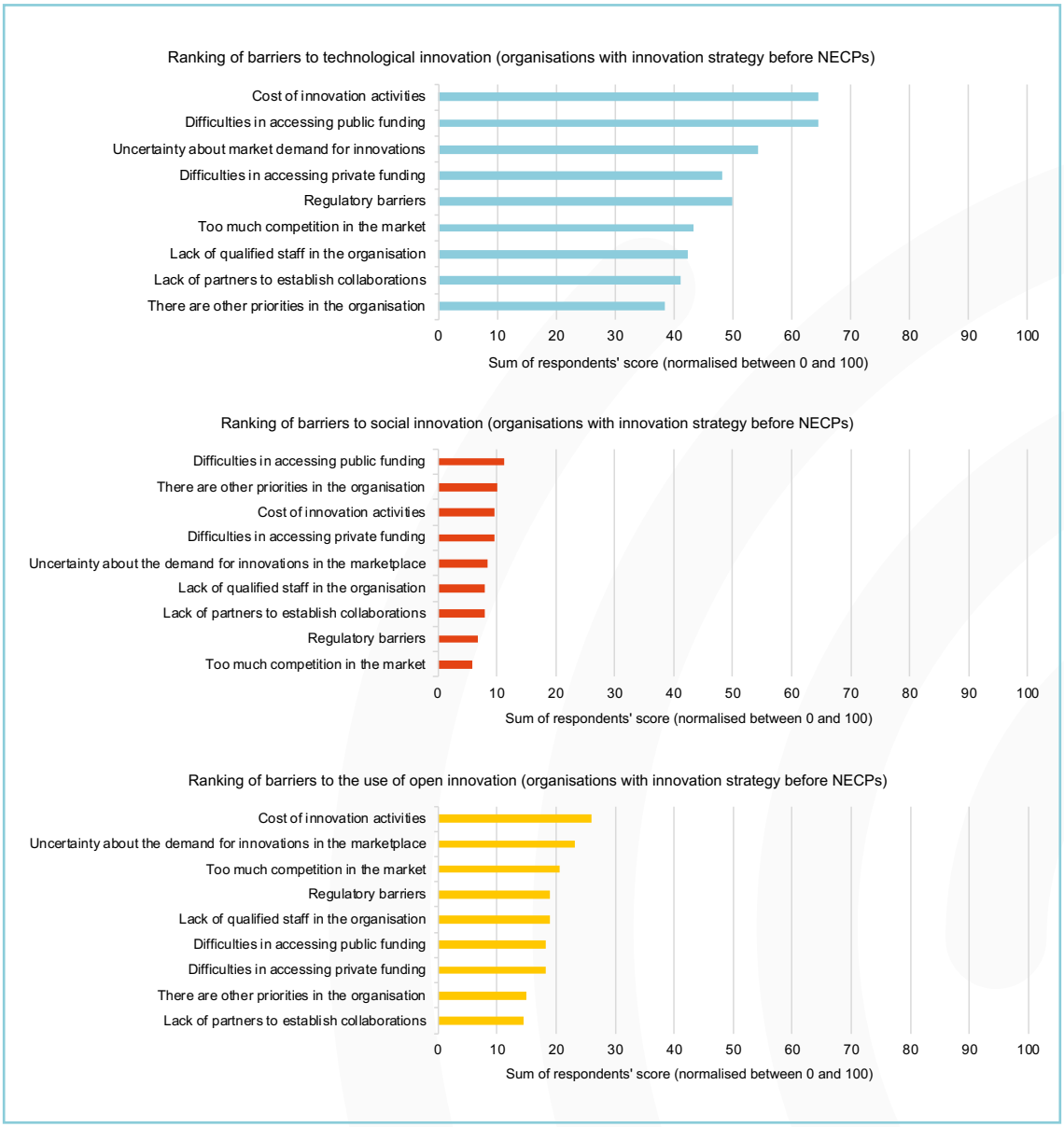

Figure 16. Ranking of barriers to technological and social innovation and open innovation activities encountered by surveyed organisations with an innovation strategy prior to the NECPs. Source: Own elaboration

Based on the responses, 47.4% of these organisations believe that the NECP will encourage technological, social, open, and regulatory innovation, 45% that it will neither encourage nor discourage it, and only 8% believe that it will discourage it. The following figure presents the relationship between the respondents' selections.

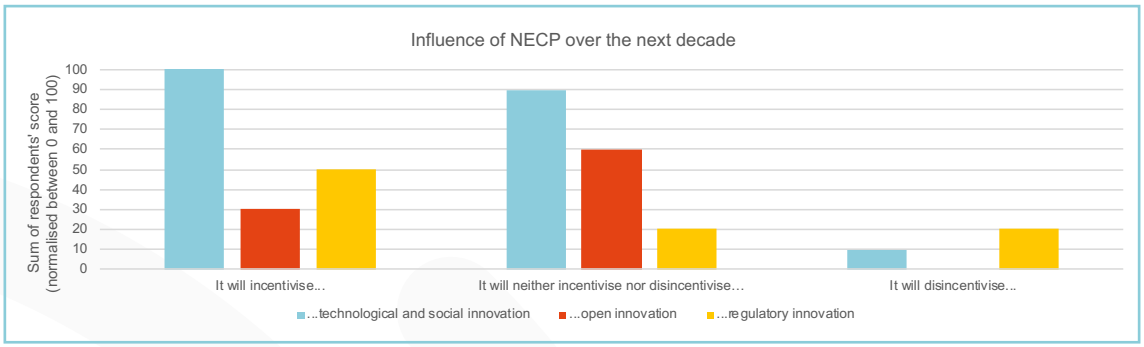

Figure 17. Opinion of the surveyed organisations on the influence of NECPs on technological and social innovation and on open innovation activities. Source: Own elaboration.

These organisations recognize the importance of the NECPs, since for 61% it has influenced the redesign of their innovation strategy. In addition, they have strengthened technological innovation activities and the use of open innovation. The organisations surveyed believe that energy transition plans influence innovation, allowing them to transform their business models, changing the priority of innovation projects to be launched. And they highlight the creation of better incentives for innovation to face the challenges of the energy transition. Similarly, those surveyed express their opinion on some shortcomings of the NECPs, such as their increased attention on the renewable electricity sector and blocking other energy alternatives. In this sense, they believe that the biofuels and synthetic fuels sector are options that should be strengthened, especially after the war in Ukraine. Other respondents believe that NECPs do not address the vulnerable consumer and do not introduce clear regulatory support for security-related issues stemming from climate change.

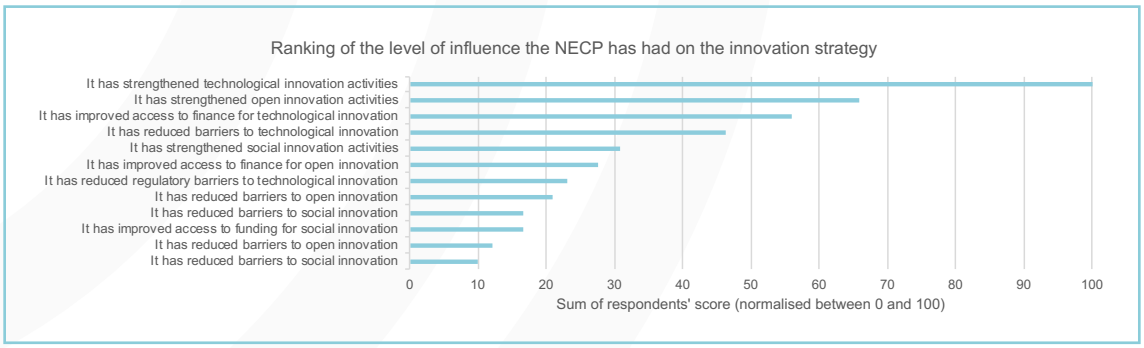

Figure 18. Ranking of the level of influence NECPs have had on the strategy of the organisations surveyed. Source: Own elaboration.

Among the organisations surveyed, 27% acknowledged not having an innovation strategy prior to the launch of the NECPs in their country. The objectives of their strategies in order of importance are the creation of value for their clients, increasing market share, accessing new markets, reducing the social and environmental impact of their organisations and reducing production costs.

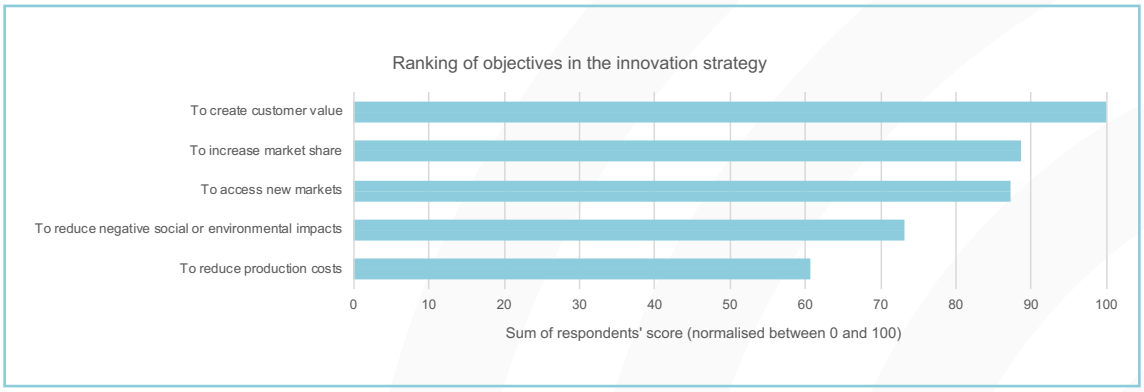

Figure 19. Ranking of the objectives in the innovation strategies of the organisations surveyed. Source: Own elaboration.

Of the organisations surveyed, 53% reported that they had not yet been able to introduce new or significantly improved goods or services. The 47% that did achieve it stated that the turnover was in the range of over 20% for new or significantly improved products that, in addition to being new for their organisation, were also new for the market; for unaltered or slightly modified products (including products completely developed and produced by others), the turnover was more substantial and in the range between 15% and 20%; and for the products that were only new for the organisation, the turnover was more prominent and was in the range of 5% and 15%. It was reported by 56.3% of these organisations that their innovations were carried out in cooperation with other organisations. For 47%, it is still too early to assess whether the expectations expected in these innovations were met.

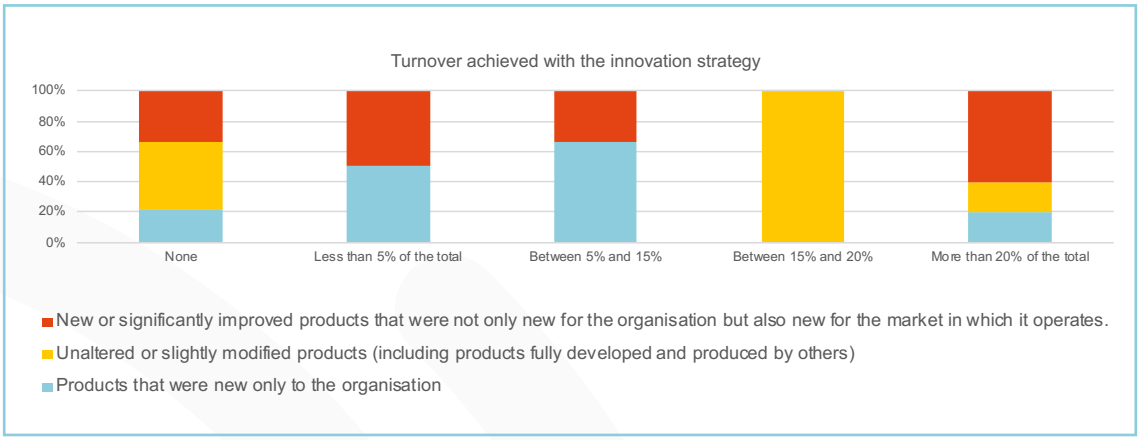

Figure 20. Business volume achieved in the organisations surveyed with the innovation strategy designed after the NECPs. Source: Own elaboration

Based on their innovation strategy, after the launch of the NECPs in their country, almost 16% of these organisations carried out activities related to technological and social innovation linked to the circular economy. Regarding activities related to open innovation, they mainly carried out R&D activities in general and related to processes or business models. These organisations reported having encountered regulatory barriers, mainly to the development of activities linked to *Blockchain*. In relation to regulatory barriers, they openly referred to the uncertainties in the application of European directives and in the legislative development of innovative technologies in the field of energy generation, storage and management. Similarly, regarding energy market operations, they reported excessive requirements that limit the possibility of advancing in the projects. The degree of affectation of these regulatory barriers is medium and high.

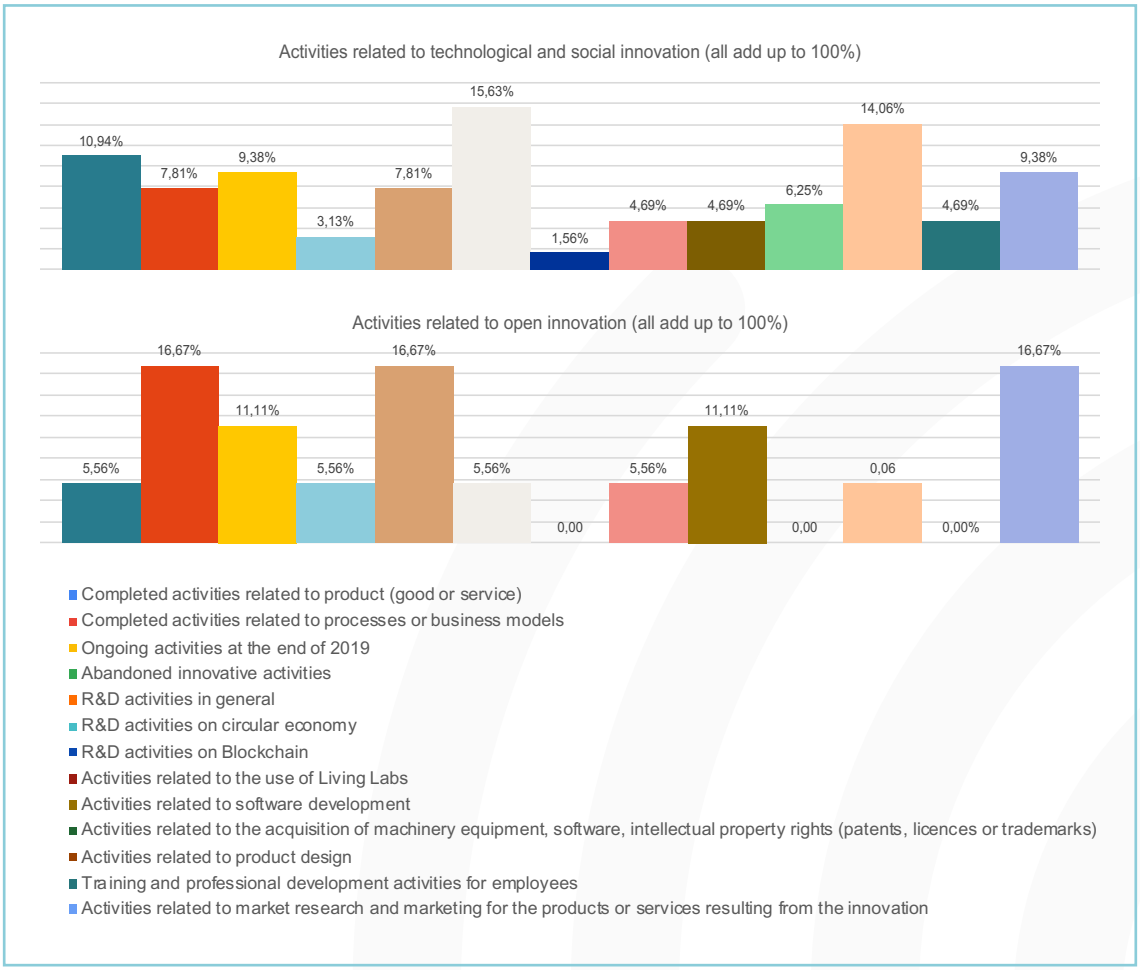

Figure 21. Activities related to technological and social innovation, as well as activities related to open innovation, carried out by the organisations surveyed with an innovation strategy designed after the NECPs. Source: Own elaboration

In organisations with an innovation strategy that was implemented after the publication of their country's NECPs, the sources of funding were mainly tax credits or deductions, grants, subsidized loans and loan guarantees from the Horizon 2020 program for Research and Innovation of the Union European Union (excluding public procurement), for technological and social innovation and for the use of open innovation.

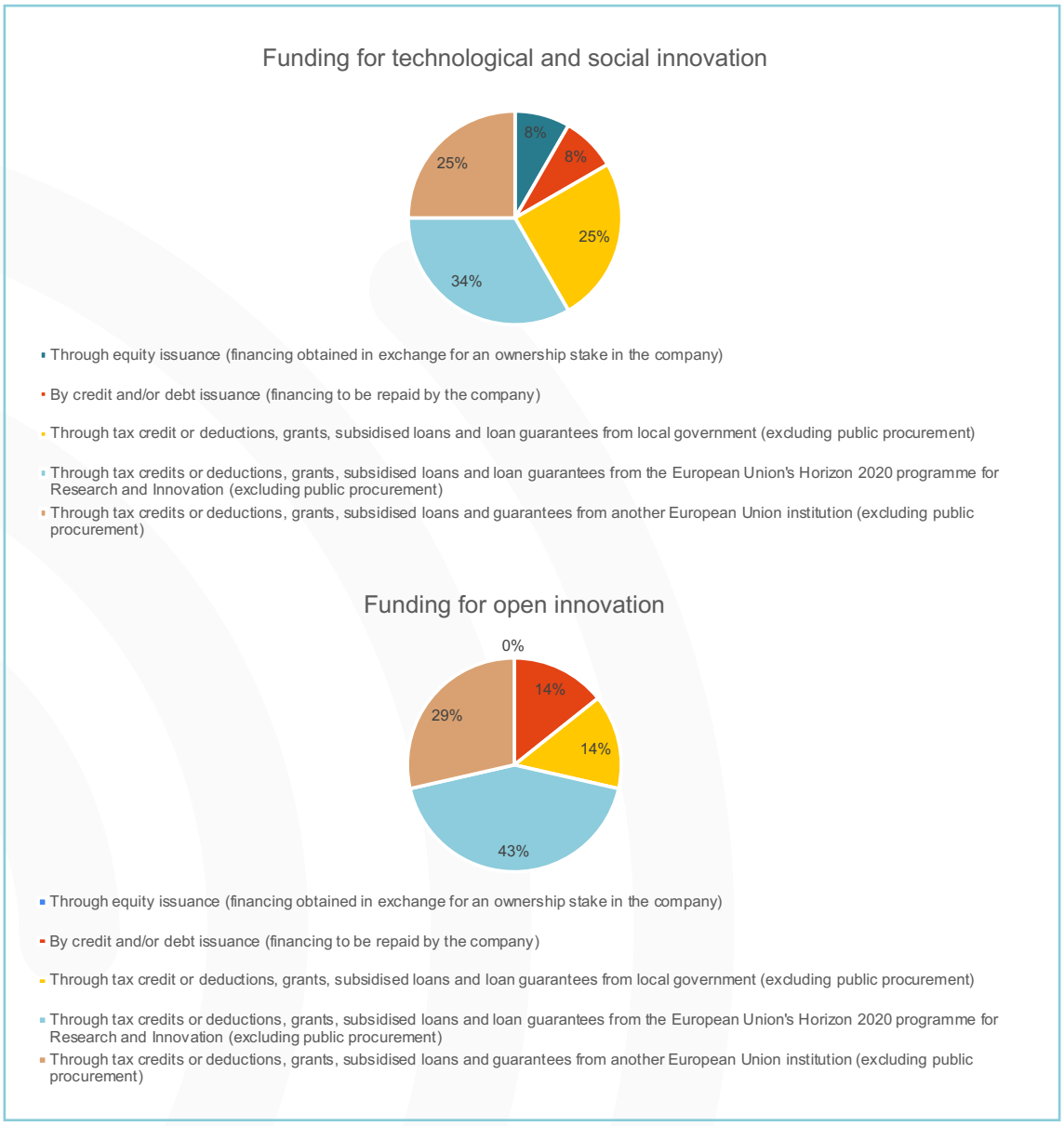

Figure 22. Source of funding for technological and social innovation and open innovation activities of surveyed organisations with an innovation strategy designed after the NECPs. Source: Own elaboration.

These organisations reported barriers related to difficulties in accessing financing both in the development of technological and social innovation and in the use of open innovation. These organisations are primarily of the opinion that NECPs will incentivize technological and social innovation.

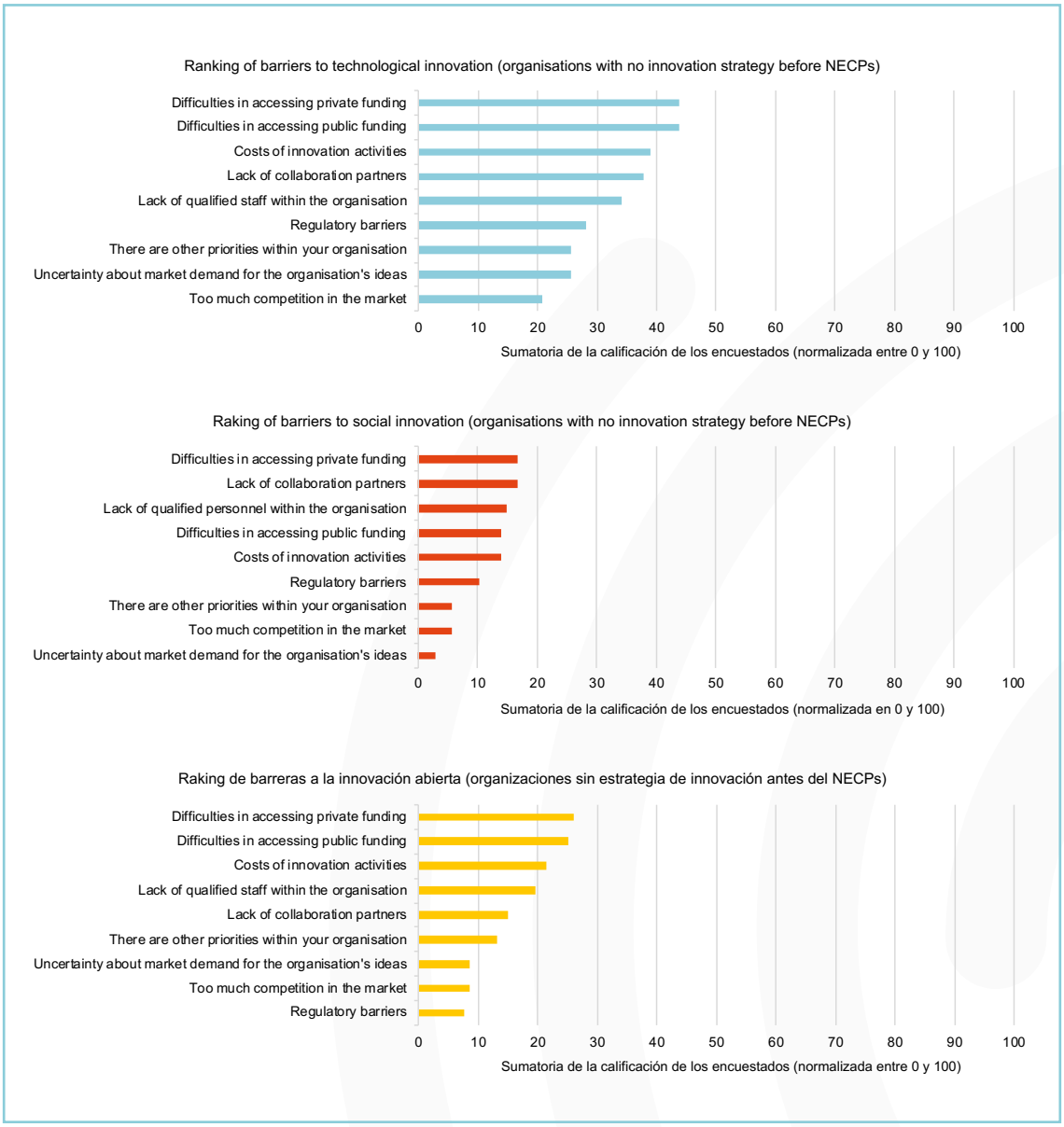

Figure 23. Business volume achieved in the organisations surveyed with the innovation strategy designed after the NECPs. Source: Own elaboration.

CONCLUSIONS

In a context such as the one we currently find ourselves in, one in which concerns about the impact of climate change are ever-greater, development and technological innovation emerge as key strategic factors that are capable of responding to this challenge. For this reason, public policies are necessary to reinforce energy efficiency and incentives for the introduction of technologies that are low in CO_2 emissions.

Since its creation, developed economies have implemented public policies to support R&D, aimed at increasing both public and private investment for research and technological development in the energy sector, which will allow us to advance in the technological frontier. Undoubtedly, consolidating and increasing support for R+D+i constitutes the best mechanism for improving the productivity of our economy, and even more so at a time like the present, in which the economic effects derived from the health pandemic of COVID-19 require policies to recover economic activity.

Technological progress can create new business opportunities, which cannot and should not be missed. Europe is currently the world leader in certain technologies, especially those of renewable origin, which are an important engine of economic and social development.

Europe's transformation into a sustainable economy, a world leader in a diverse set of clean, efficient and low-carbon energy technologies, would be synonymous with our ability to capitalize on the opportunities arising from the threats associated with energy dependency on foreign sources and climate change.

On the other hand, these are opportunities that do not go unnoticed by companies that identify technological, process and product innovation as one of the key factors with the greatest impact on business efficiency. However, and despite the Community efforts of the community to provide the European Union with a coordinated political framework to promote research and tech-

nological innovation, and the importance that private agents give to this field, the results are far from optimal. In the energy sector, any indicator that is used shows a lower level of research, and this is something which must be corrected. The ratios of spending on research and development, both at the sectoral level and at the individual level, although they have been improving in recent years, are far from those observed in other industrial sectors as they are facing significant obstacles.

Investing more and better in new energy technologies is the only way to face the challenge of guaranteeing energy supply, in a sustainable way and at competitive prices. Transforming the current energy system is not only a matter of budget allocation. It also requires strategic action, proactive planning and an ambitious policy framework to promote technological innovation.

This strategic commitment requires greater knowledge of the reality of our production network, its characteristics, its competitive advantages, as well as the difficulties faced when undertaking innovation processes.

Competitiveness has become a necessary condition to remain in the market, that is, to survive. For a better understanding of the factors that determine the survival of companies, it is necessary to understand the current competitive environment, the factors that affect competitiveness and the role that innovation plays in all of this, as well as the different policies to promote innovation research and development.

With this objective, the present study has been carried out. Based on an analysis of the innovation situation in Spain, France and Portugal, an attempt has been made to identify the determinants of innovation as a key resource for achieving higher levels of productivity, profitability and competitiveness.

Among these determining factors, those of an internal nature to the company itself, such as maintaining an innovative long-term strategy which allows capitalizing on the knowledge acquired, or the existence of a dynamic, flexi-

ble organisational structure, capable of incorporating changes in all functional areas, are required for technological innovation. Other factors typical of the innovation ecosystem are linked to cooperation and collaboration with other companies. In this way, a greater and more effective use of productive, commercial or technological capacities is achieved together, risks are reduced, costs are shared, economies of scale are taken advantage of and the competitive position of each of the companies in the market improves. But of equal importance is the existence of public policies to support technological innovation, and in the energy field above all, there needs to be guidelines that mark technological priorities and the areas of action to mitigate the effects that derive from of climate change.

All of the above is with a focus on the innovation actors themselves. Being aware of the need to move to the micro scale for a better understanding of the state of innovation and its determinants, this survey-based study has been carried out with public and private entities, large companies, SMEs and research centres. The aim of the study was to investigate the impact of energy policy on the scope of innovation management and financing in these organisations, with the aim of exploring key aspects and results of technological and social innovation processes, the use of open innovation and regulatory barriers that block the entry of innovations in the market. To do so, NECPs were seen as a frontier between previous energy policy and the new one, which seeks to achieve specific climate objectives by 2030. Although it is true that this survey is carried out at a time very close to the publication of the NECPs, being able to segment the protagonists of innovation between two groups of organisations with innovation strategies designed before and after the NECPs is already an important advancement for data collection that includes the enablers of innovation in the energy transition.

The results of this research show that the Sudoe region has organisations with innovation strategies linked to the challenges of the energy transition and in-line with the energy policy reflected in the NECPs. The creation of value through innovation has the consumer as the central axis of decarbonisation, which marks a highly outstanding result . For these companies, the fact of

having laid the firm foundations to be able to consolidate their trajectory towards climate neutrality for the economy and society by 2050 has been a decisive element in reinforcing their innovation strategy in the energy and climate field. In this sense, the results of this study are a starting point to further compare how NECPs have influenced organisations with more robust innovation strategies and better connected to the environment through open innovation.

Regarding the management and scope of innovation, the different innovation management models condition the potential results. Almost half of the organisations surveyed manage R+D+i from specific department that has been created for the purpose. Other respondents reported having decentralized R+D+i management mechanisms in each department and some manage it based on the projects being carried out in order to connect directly with customer requirements. In addition, open innovation mechanisms are recognized by those surveyed as ways to expand cooperation frameworks that make it possible to jointly address the challenges of the energy transition with innovations in the market.

Finally, the reality in terms of financing is far from being close to what is needed for innovations to reach the market. As was presented in the initial section of the global analysis, the expenditure on R&D+i within the gross added value of our companies linked to energy innovation is not consistent with the weight of said sector within our economy. And this anomaly is mentioned by the respondents. For this reason, an in-depth reflection on the possible explanatory causes of this reality is necessary. The lack of financing is a major barrier that has hindered further growth in the market for innovations, mainly those developed by SMEs. These companies face greater problems due to the high cost of innovation and the uncertainty looming over innovations being successful in the market. Financing support for the industrial networks generated by SMEs is decisive for achieving the objectives of the energy transition, since the creation of value for the decarbonisation of the economy stems from the dynamism generated by these companies around innovation.

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ANNEX I: TECHNICAL REFERENCES

PROJECT ACRONYM	TR@NSNET
PROJECT TITLE	Living Lab model for an ecological transition through the integration and interconnection of complex heterogeneous grids.
PROJECT COORDINATOR	George Zissis and Marie-Pierre Gleizes (Coordinators) Lou Ackerman (Project Manager)
PROJECT DURATION	01.10.2020 – 31.03.2023 (30 months)

DELIVERABLE NO.	E3.1.1 Report on Innovation
DISSEMINATION LEVEL (PU/CO)	Public
TYPE	Report
WORK PACKAGE	TG3 – Design of University Living Lab model
LEAD BENEFICIARY	Foundation for Energy and Environmental Sustainability, Funseam
CONTRIBUTING BENEFICIARY/IES	CTA and CIRCE
DUE DATE OF DELIVERABLE	2021-2022
CURRENT SUBMISSION DATE	2022

Version Record

Versión	Date	Description of changes
V1	2022	Document creation

Peer-Review and Approvals

Author/s
Joan Batalla-Bejerano and Manuel Villa Arrieta (Funseam)

Funseam wants to sincerely thank all the project's partners and institutions that have collaborated with time and effort to make this report the interesting document it is.

ANNEX II: INNOVATION SURVEY

Questionnaire on the status of innovation within the framework of the energy transition

2021

Tr@nsnet european research project

Privacy statement:

All responses will be strictly confidential. The names and institutions of the participants will not be published in any medium. The results of this study will only be used in aggregate form for scientific research purposes and will not be accessible to third parties.

A.I.M.:

The AIM of this questionnaire is to find out your thoughts on the current status of innovation within the framework of the energy transition. We ask you to consider whether the innovation strategies that your organisation has proposed are aligned with the objectives of the energy transition. Before you begin, please consider the following definitions:

Definitions:

- **Energy transition:**
  This refers to the long-term structural chance of energy systems that allows for the economy to be decarbonised. The measures related to this process that are used in this questionnaire are defined in National Energy and Climate Plans 2021-2030, NECP, (France Plan National Integrate Energy-Climat / Portugal Plano Nacional Energia e Clima).
  The NECP is based on the european commission's long-term strategic vision for "A clean planet for all" (COM (2018) 773 end), in order for the EU to achieve a prosperous, modern, competitive and carbon-neutral economy by 2050.

- **Innovation:**
  This refers to the process by which changes are implemented in the market, either by modifying existing elements in order to improve them, or by introducing entirely new elements.
  For example: the creation of the smartphone to replace traditional forms of communication as well as provide us with a device to perform tasks remotely wherever we are.

- **R&d&i (research, development and innovation):**
  This refers to the process of investing in research to obtain knowledge that is developed in order to obtain benefits through (mainly economic) innovation in the market.

- **Open innovation:**
  This refers to a model of innovation management based on collaboration between individuals and entities outside the company, building on research and development of external knowledge.
  For example: programs to promote collaboration between external companies to improve production processes in specific facilities.

- **Technological innovation:**
  This refers to a new or significantly improved product or production process. It includes new or significantly improved techniques, components, materials or software.
  For example: creating printed solar cells using solar energy receiver inks in economical ways and with practical applications.

- **Social innovation:**
  This refers to new ideas for products, services or business models that satisfy social needs and simultaneously create new collaborative relationships with society.
  For example: developing mobile applications that allow a group of neighbours to connect and help each other in their daily lives or to monitor shared spaces and their resources.

- **Regulatory innovation:**
  This refers to new regulatory ideas that are in line with technological and social innovations, making it easier for new products, services or business models to enter the market while also protecting consumer interests.
  For example: adapting the current regulations to allow applications to promote shared use of different means of transport to enter the market.

- **Structure of the questionnaire:**
  We aim to explore technological, social and regulatory innovation in different aspects of organisations' innovation strategy before and after the start of the NECP.

RESPONDENT PROFILE:

1. Please indicate your role:

- ☐ Administrator
- ☐ Engineer
- ☐ Analyst
- ☐ Lawyer / Legal adviser
- ☐ Consultant
- ☐ Director
- ☐ Specialist
- ☐ Owner
- ☐ Vice president
- ☐ Other: .....

ABOUT THE ORGANISATION:

2. Type of organisation

- ☐ University
- ☐ Public institution
- ☐ Research association or other research institutions
- ☐ Private with < 10% equity participation
- ☐ Private with >10% and <50% foreign capital participation
- ☐ Private with >50% foreign capital participation

Other: .....

3. How big is your organisation?

- ☐ Micro (fewer than 10 employees, turnover of less than or equal to €2m and a balance of less than or equal to €2m)

- ☐ Small (fewer than 50 employees, turnover of less than or equal to €10m and a balance of less than or equal to €10m)
- ☐ Medium (fewer than 250 employees, turnover of less than or equal to €50m and a balance of less than or equal to €43m)
- ☐ Big company

4. **Country where headquarters is located:** .....

QUESTIONS ON INNOVATION:

5. **How is R&D&I managed in your organisation?**

- ☐ R&D&I management (direct relationship with the company's board of directors, has its own decision-making power, autonomy and own budget)
- ☐ The organisation has its own R&D&I department
- ☐ The organisation has a R&D&I section or unit that is dependent on another department
- ☐ It is outsourced
- ☐ There is a head of R&D&I
- ☐ Organisation personnel dedicate part of their time to R&D&I

6. **What percentage of turnover does your organisation allocate to R&D&I?**

Year	Less than 5%	Between 5% and 15%	Between 15% and 20%	More than 20%
2019				
2020				

7. **How does your organisation plan and carry out R&D&I activities?**

- ☐ Each department carries out their own R&D&I activities
- ☐ There are research centres linked to the university
- ☐ Other

8. **Does your organisation participate in the exchange of intellectual property and technology abroad? In what ways?** Answer only if yes.

.....

9. **Does your organisation participate in national- or European-funded projects in collaboration with another organisation?**

- ☐ And it is
- ☐ Nope

10. **Does your organisation participate in innovation projects with partners from the following countries?**

- ☐ Spain
- ☐ France
- ☐ Portugal

Other countries: .....

11. **Does your organisation have a general strategy or rules for participating in innovation projects with external organisations?**

☐ And it is
☐ Nope

12. **Does your organisation have memoranda of understandings, agreements or similar with public and/or private companies?**

☐ And it is
☐ Nope

13. **In order to carry out R&D activities, what type of partner do you look for? Please prioritize the following options on a scale from 0 (no priority) and 5 (highest level of priority)**

	0	1	2	3	4	5
Universities	☐	☐	☐	☐	☐	☐
start-up companies	☐	☐	☐	☐	☐	☐
Private companies	☐	☐	☐	☐	☐	☐
Research centres	☐	☐	☐	☐	☐	☐

14. **Are you familiar with what the following actions mean? Have you implemented or been a beneficiary of them in an attempt to jointly develop technologies or to promote connections with other actors?** Check only those that apply to you

	Have you attempted to jointly develop technologies?	Have you promoted connecting with other actors?	Have you been a beneficiary of an attempt to jointly develop technologies?	Have you been a beneficiary of promoting connecting with other actors?
Exploration mission	☐	☐	☐	☐
Hackathon (A sprint-type design event in which ICT developers collaborate intensively on software projects)	☐	☐	☐	☐
Resource sharing	☐	☐	☐	☐
Challenge awards	☐	☐	☐	☐
Corporate accelerator	☐	☐	☐	☐
Corporate venture capital	☐	☐	☐	☐
Incubator (designed to support start-ups with ideation from beginning to end)	☐	☐	☐	☐
Corporate incubator (similar to accelerators, normally three months' support for start-ups)	☐	☐	☐	☐
Strategic partnerships	☐	☐	☐	☐

15. **Do you have a specific strategy to share the results of your R&D different from innovation with the public/private sector? For example, patent transfer programs etc.** Answer only if yes

.....

16. **Did your organisation propose an innovation strategy prior to the publication of the NECP?**

☐ Yes, we had it before the NECP was published
☐ No, we designed it after the NECP was published

SPLIT 1: ANSWER YES

17. **Indicate on a scale of 0 to 5 the level of importance the aims of this innovation strategy have. Importance** (0 is the lowest and 5 the highest level of importance)

AIM	0	1	2	3	4	5
Create value for the customer	☐	☐	☐	☐	☐	☐
Increase market share	☐	☐	☐	☐	☐	☐
Access new markets	☐	☐	☐	☐	☐	☐
Reduce production costs	☐	☐	☐	☐	☐	☐
Reduce the company's negative social or environmental impact	☐	☐	☐	☐	☐	☐

18. **Has your organisation managed to introduce new or significantly improved goods or services to the market using this strategy?**

☐ And it is
☐ Nope

19. **If your organisation has managed to introduce new or significantly improved goods or services to the market using this strategy, indicate the percentage of the turnover in the 2019 accounting period due to:**

Item	None	Less than 5%	Between 5% & 15%	Between 15% & 20%	More than 20%
Products that were new to only your organisation	☐	☐	☐	☐	☐
Products that were new or significantly improved in addition to being new to both your organisation and the market in which it operates	☐	☐	☐	☐	☐
Products that were unchanged or only slightly modified (including products fully-developed and produced by others)	☐	☐	☐	☐	☐

20. If your organisation has managed to introduce new or significantly improved goods or services to the market using this strategy, indicate the percentage of the turnover in the 2020 accounting period due to:

Item	None	Less than 5%	Between 5% & 15%	Between 15% & 20%	More than 20%
Products that were new to only your organisation	☐	☐	☐	☐	☐
Products that were new or significantly improved in addition to being new to both your organisation and the market in which it operates	☐	☐	☐	☐	☐
Products that were unchanged or only slightly modified (including products fully-developed and produced by others)	☐	☐	☐	☐	☐

21. Who developed these product innovations (goods or services)?

☐ Just your organisation
☐ Your organisation in cooperation with other organisations or group of organisations
☐ Your organisation through the adaptation or modification of goods or services originally developed by other organisations
☐ Other organisations

Comments: .....

22. Assess to what extent your expectations regarding the product innovations were fulfilled.
Choose only one option

	Expectations were exceeded	Expectations were met	Expectations were met only up to a point	Expectations were not met	It is too early to assess the results
In 2019	☐	☐	☐	☐	☐
In 2020	☐	☐	☐	☐	☐

23. **Based on this innovation strategy, has your organisation carried out any of the following activities?** Check only if yes.

Activities	Related to technological innovation	Related to social innovation	Related to open innovation	Where you encountered regulatory barriers
Completed activities related to product (goods or services)	☐	☐	☐	☐
Completed activities related to business processes or models	☐	☐	☐	☐
Activities ongoing at the end of 2019	☐	☐	☐	☐
Innovation activities that were abandoned	☐	☐	☐	☐
R&D activities in general	☐	☐	☐	☐
R&D activities on the circular economy	☐	☐	☐	☐
R&D activities on Blockchain	☐	☐	☐	☐
Activities related to the use of Living Labs	☐	☐	☐	☐
Activities related to software development	☐	☐	☐	☐
Activities related to the acquisition of machinery equipment, software, intellectual property rights (patents, licenses, or registered trademarks)	☐	☐	☐	☐
Activities related to product design	☐	☐	☐	☐
Activities for employee training and professional development	☐	☐	☐	☐
Activities related to market research and marketing for products and services resulting from innovation	☐	☐	☐	☐

24. **In the event that you encountered regulatory barriers in any of the above activities, please explain what type they were:**

.....

25. **Indicate on a scale from 0 to 5 the extent to which this regulatory barrier has affected your organisation's innovation strategy, with 0 being no impact and 5 being a very high level of impact:**

	0	1	2	3	4	5
Level of impact	☐	☐	☐	☐	☐	☐

26. **Have you obtained funding to carry out the above innovation activities through any of the following means for technological innovation, social and/or open innovation?** Mark only those which apply

Source of funding	For technological innovation	For social innovation	For open innovation
By issuing shares (financing obtained in exchange for a stake in the ownership of the company)	☐	☐	☐
Through credits and / or debt issuance (financing that the company must return)	☐	☐	☐
Through tax credits or deductions, grants, subsidized loans and guarantees of loan from local administrations (excluding public procurement)	☐	☐	☐
Through tax credits or deductions, grants, subsidized loans and guarantees of loans from the EU's Horizon 2020 for Research and Innovation program (excluding public procurement)	☐	☐	☐
Through tax credits or deductions, grants, subsidized loans and guarantees from another European Union institution (excluding public procurement)	☐	☐	☐

27. **If the innovation strategy your organisation has carried out includes activities related to TECHNOLOGICAL INNOVATION, indicate the severity of the problems you encountered on a scale of 0 (low) to 5 (high).** Do not complete if the problem was not encountered

Problem	0	1	2	3	4	5
Difficulties in accessing public funding	☐	☐	☐	☐	☐	☐
Difficulties in accessing private funding	☐	☐	☐	☐	☐	☐
Costs of innovation activities	☐	☐	☐	☐	☐	☐
Lack of qualified personnel within the organisation	☐	☐	☐	☐	☐	☐
Lack of partners for collaboration	☐	☐	☐	☐	☐	☐
Uncertainty regarding the market demand for the organisation's ideas	☐	☐	☐	☐	☐	☐
Too much competition in the market	☐	☐	☐	☐	☐	☐
The organisation has other priorities	☐	☐	☐	☐	☐	☐
Regulatory barriers	☐	☐	☐	☐	☐	☐

28. **If the innovation strategy your organisation has carried out includes activities related to SOCIAL INNOVATION, indicate the severity of the problems you encountered on a scale of 0 (low) to 5 (high).** Do not complete if the problem was not encountered

Barrier	0	1	2	3	4	5
Difficulties in accessing public funding	☐	☐	☐	☐	☐	☐
Difficulties in accessing private funding	☐	☐	☐	☐	☐	☐
Costs of innovation activities	☐	☐	☐	☐	☐	☐
Lack of qualified personnel within the organisation	☐	☐	☐	☐	☐	☐
Lack of partners for collaboration	☐	☐	☐	☐	☐	☐
Uncertainty regarding the market demand for the organisation's ideas	☐	☐	☐	☐	☐	☐
Too much competition in the market	☐	☐	☐	☐	☐	☐
The organisation has other priorities	☐	☐	☐	☐	☐	☐
Regulatory barriers	☐	☐	☐	☐	☐	☐

29. **If the innovation strategy your organisation has carried out includes activities related to OPEN INNOVATION, indicate the severity of the problems you encountered on a scale of 0 (low) to 5 (high).** Do not complete if the problem was not encountered

Barrier	0	1	2	3	4	5
Difficulties in accessing public funding	☐	☐	☐	☐	☐	☐
Difficulties in accessing private funding	☐	☐	☐	☐	☐	☐
Costs of innovation activities	☐	☐	☐	☐	☐	☐
Lack of qualified personnel within the organisation	☐	☐	☐	☐	☐	☐
Lack of partners for collaboration	☐	☐	☐	☐	☐	☐
Uncertainty regarding the market demand for the organisation's ideas	☐	☐	☐	☐	☐	☐
Too much competition in the market	☐	☐	☐	☐	☐	☐
The organisation has other priorities	☐	☐	☐	☐	☐	☐
Regulatory barriers	☐	☐	☐	☐	☐	☐

30. **What influence do you think the NECP will have over the next decade?**

Options	Technological innovation	Social innovation	Open innovation	Regulatory innovation
It will be encouraged.	☐	☐	☐	☐
It will be neither encouraged or discouraged.	☐	☐	☐	☐
It will be discouraged	☐	☐	☐	☐

31. **Has the NECP influenced how your organisation's innovation strategy has been redesigned?**

☐ And it is
☐ Nope

SPLIT 2: ANSWER YES

32. **On a scale from 0 (nil) - 5 (maximum), rate the following statements describing the level of influence that the NECP has had on your innovation strategy.**

	0	1	2	3	4	5
It has strengthened technological innovation activities	☐	☐	☐	☐	☐	☐
It has strengthened social innovation activities	☐	☐	☐	☐	☐	☐
It has strengthened open innovation activities	☐	☐	☐	☐	☐	☐
It has reduced regulatory barriers to technological innovation	☐	☐	☐	☐	☐	☐
It has reduced barriers to social innovation	☐	☐	☐	☐	☐	☐
It has reduced barriers to open innovation	☐	☐	☐	☐	☐	☐
Access to finance for technological innovation has improved	☐	☐	☐	☐	☐	☐
Access to finance for social innovation has improved	☐	☐	☐	☐	☐	☐
Access to finance for open innovation has improved	☐	☐	☐	☐	☐	☐
It has reduced barriers to technological innovation	☐	☐	☐	☐	☐	☐
It has reduced barriers to social innovation	☐	☐	☐	☐	☐	☐
It has reduced barriers to open innovation	☐	☐	☐	☐	☐	☐

33. **Please comment on any other aspects regarding the influence of the energy transition strategy in relation to innovation that you consider relevant.**

.....

34. **Would you like to receive the final report with the aggregated results of the survey? If so, provide your email address below.**

.....

SPLIT 1: ANSWER NO

17. **Indicate on a scale of 0 to 5 the level of importance the aims of this innovation strategy have. Importance** (0 is the lowest and 5 the highest level of importance)

AIM	0	1	2	3	4	5
Create value for the customer	☐	☐	☐	☐	☐	☐
Increase market share	☐	☐	☐	☐	☐	☐
Access new markets	☐	☐	☐	☐	☐	☐
Reduce production costs	☐	☐	☐	☐	☐	☐
Reduce the company's negative social or environmental impact	☐	☐	☐	☐	☐	☐

18. **Has your organisation managed to introduce new or significantly improved goods or services using this innovation strategy?**

☐ And it is
☐ Nope

19. **If your organisation has managed to introduce new or significantly improved goods or services to the market using this strategy, indicate the percentage of the turnover accounting due to:**

Item	None	Less than 5%	Between 5% & 15%	Between 15% & 20%	More than 20%
Products that were new to only your organisation	☐	☐	☐	☐	☐
Products that were new or significantly improved in addition to being new to both your organisation and the market in which it operates	☐	☐	☐	☐	☐
Products that were unchanged or only slightly modified (including products fully-developed and produced by others)	☐	☐	☐	☐	☐

20. **Who developed these product innovations (goods or services)?**

☐ Just your organisation
☐ Your organisation in cooperation with other organisations or group of organisations
☐ Your organisation through the adaptation or modification of goods or services originally developed by other organisations
☐ Other organisations

Comments: .....

21. **Assess to what extent your expectations regarding the product innovations were fulfilled.**
Choose only one option

☐ Expectations were exceeded
☐ Expectations were met
☐ Expectations were met only up to a point
☐ Expectations were not met
☐ It is too early to assess the results

22. **Based on this innovation strategy, has your organisation carried out any of the following activities?** Check only if yes.

Activities	Related to technological innovation	Related to social innovation	Related to open innovation	Where you encountered regulatory barriers
Completed activities related to product (goods or services)	☐	☐	☐	☐
Completed activities related to business processes or models	☐	☐	☐	☐
Activities ongoing at the end of 2019	☐	☐	☐	☐
Innovation activities that were abandoned	☐	☐	☐	☐
R&D activities in general	☐	☐	☐	☐
R&D activities on the circular economy	☐	☐	☐	☐
R&D activities on Blockchain	☐	☐	☐	☐
Activities related to the use of Living Labs	☐	☐	☐	☐
Activities related to software development	☐	☐	☐	☐
Activities related to the acquisition of machinery equipment, software, intellectual property rights (patents, licenses, or registered trademarks)	☐	☐	☐	☐
Activities related to product design	☐	☐	☐	☐
Activities for employee training and professional development	☐	☐	☐	☐
Activities related to market research and marketing for products and services resulting from innovation	☐	☐	☐	☐

23. **In the event that you encountered regulatory barriers in any of the above activities, please explain what type they were:**

.....

24. **Indicate on a scale from 0 to 5 the extent to which this regulatory barrier has affected your organisation's innovation strategy, with 0 being no impact and 5 being a very high level of impact:**

	0	1	2	3	4	5
Level of impact	☐	☐	☐	☐	☐	☐

25. **Have you obtained funding to carry out the above innovation activities through any of the following means for technological innovation, social and/or open innovation?** Mark only those which apply

Source of funding	For technological innovation	For social innovation	For open innovation
By issuing shares (financing obtained in exchange for a stake in the ownership of the company)	☐	☐	☐
Through credits and / or debt issuance (financing that the company must return)	☐	☐	☐
Through tax credits or deductions, grants, subsidized loans and guarantees of loan from local administrations (excluding public procurement)	☐	☐	☐
Through tax credits or deductions, grants, subsidized loans and guarantees of loans from the EU's Horizon 2020 for Research and Innovation program (excluding public procurement)	☐	☐	☐
Through tax credits or deductions, grants, subsidized loans and guarantees from another European Union institution (excluding public procurement)	☐	☐	☐

26. **If the innovation strategy your organisation has carried out includes activities related to TECHNOLOGICAL INNOVATION, indicate the severity of the problems you encountered on a scale of 0 (low) to 5 (high).** Do not complete if the problem was not encountered

Problem	0	1	2	3	4	5
Difficulties in accessing public funding	☐	☐	☐	☐	☐	☐
Difficulties in accessing private funding	☐	☐	☐	☐	☐	☐
Costs of innovation activities	☐	☐	☐	☐	☐	☐
Lack of qualified personnel within the organisation	☐	☐	☐	☐	☐	☐
Lack of partners for collaboration	☐	☐	☐	☐	☐	☐
Uncertainty regarding the market demand for the organisation's ideas	☐	☐	☐	☐	☐	☐
Too much competition in the market	☐	☐	☐	☐	☐	☐
The organisation has other priorities	☐	☐	☐	☐	☐	☐
Regulatory barriers	☐	☐	☐	☐	☐	☐

27. **If the innovation strategy your organisation has carried out includes activities related to SOCIAL INNOVATION, indicate the severity of the problems you encountered on a scale of 0 (low) to 5 (high).** Do not complete if the problem was not encountered

Barrier	0	1	2	3	4	5
Difficulties in accessing public funding	☐	☐	☐	☐	☐	☐
Difficulties in accessing private funding	☐	☐	☐	☐	☐	☐
Costs of innovation activities	☐	☐	☐	☐	☐	☐
Lack of qualified personnel within the organisation	☐	☐	☐	☐	☐	☐
Lack of partners for collaboration	☐	☐	☐	☐	☐	☐
Uncertainty regarding the market demand for the organisation's ideas	☐	☐	☐	☐	☐	☐
Too much competition in the market	☐	☐	☐	☐	☐	☐
The organisation has other priorities	☐	☐	☐	☐	☐	☐
Regulatory barriers	☐	☐	☐	☐	☐	☐

28. **If the innovation strategy your organisation has carried out includes activities related to OPEN INNOVATION, indicate the severity of the problems you encountered on a scale of 0 (low) to 5 (high).** Do not complete if the problem was not encountered

Barrier	0	1	2	3	4	5
Difficulties in accessing public funding	☐	☐	☐	☐	☐	☐
Difficulties in accessing private funding	☐	☐	☐	☐	☐	☐
Costs of innovation activities	☐	☐	☐	☐	☐	☐
Lack of qualified personnel within the organisation	☐	☐	☐	☐	☐	☐
Lack of partners for collaboration	☐	☐	☐	☐	☐	☐
Uncertainty regarding the market demand for the organisation's ideas	☐	☐	☐	☐	☐	☐
Too much competition in the market	☐	☐	☐	☐	☐	☐
The organisation has other priorities	☐	☐	☐	☐	☐	☐
Regulatory barriers	☐	☐	☐	☐	☐	☐

29. **What influence do you think the NECP will have over the next decade?**

Options	Regarding technological innovation	Regarding social innovation	Regarding open innovation	Regarding regulatory innovation
It will be encouraged	☐	☐	☐	☐
It will be neither encouraged or discouraged	☐	☐	☐	☐
It will be discouraged	☐	☐	☐	☐

30. **Please comment on any other aspects regarding the influence of the energy transition strategy in relation to innovation that you consider relevant.**

.....

31. Would you like to receive the final report with the aggregated results of the survey? If so, provide your email address below.

.....

SPLIT 2: ANSWER NO

34. Please comment on any other aspects regarding the influence of the energy transition strategy in relation to innovation that you consider relevant.

.....

35. Would you like to receive the final report with the aggregated results of the survey? If so, provide your email address below.

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Fundación para la Sostenibilidad Energética y Ambiental

Foundation for Energy and Environmental Sustainability 2022