European Research Council
Established by the European Commission

European Commission

Use of patents: empirical evidence from a survey of grantees of the European Research Council (ERC)

2024

Introduction

The “Survey on the use of patents by ERC grantees” was launched in November 2023 as part of an action outlined in the Annual Work Plan 2023-2024 of the ERC Scientific Council Working Group (WG) on Innovation. The objective was to analyse technology transfer activities of ERC grantees, including the quantification and analysis of licensing and other uses of patents (and patent applications) reported as resulting from ERC-funded projects.

Out of the over 12,000 researchers holding ERC grants at the time of launching the survey, the analysis focused on those grantees who declared that they had filed patent applications resulting from their ERC-funded research, (“self-declared patent applications”)[1].

A previous study conducted for the ERC, “Assessing the Influence of ERC-funded Research on Patented Inventions” (Munari et al., 2023)[2], published in January 2023, provided a comprehensive dataset covering self-declared patent applications. The dataset included 1,550 self-declared patent applications linked to more than 700 ERC-funded projects that had at least one self-reported patent application (in FP7 and part of H2020), out of a total sample of 6,671 projects. Each self-declared patent application in the dataset was linked to the respective research project funded by the ERC, including the project Principal Investigator (PI), the ERC scientific domain and evaluation panel, the Host Institution, and other relevant information.

The Secretariat of the Innovation WG at the ERC Executive Agency (ERCEA) consulted with academics who possessed in-depth knowledge and expertise on the subject[3], providing valuable inputs and suggestions on how to organise the survey and develop the questionnaire. This consultation was inspired by two large surveys on patent uses, PatVal and InnoS&T[4], and was instrumental in informing the design of the questionnaire.

The ERCEA team prepared a test questionnaire, which was sent to nine ERC grantees for feedback and input. Their comments were incorporated to draft the final version of the questionnaire. The survey was then sent out on 14 November 2023 and closed in the first week of January 2024. This paper presents an analysis of the responses.

Objectives of the study

The analysis of the use of patents resulting from research projects is one way to measure and assess the impact beyond science of ERC-funding. This measure, along with others such as the creation of new startup companies, research collaborations, and public engagement initiatives, represents a direct channel through which the effects of publicly funded research are transferred to the economy and society at large.

The “Survey on the use of patents by ERC grantees” is part of a broader analysis on the extent to which publicly funded frontier research influences technological progress. This analysis includes the following three activities focused on ERC-funded science:

1. Analysis of patent citations to ERC-funded science (non-patent literature citations in patents citing scientific papers acknowledging ERC funding - Munari et al., 2023).
2. Analysis of companies created or co-created by ERC PIs or team members or created as a result of ERC-funded research.
3. Survey to inventors of patent applications resulting from ERC-funded projects (described in this document).

1 ERC grantees report their patent applications to the ERC Executive Agency (ERCEA) in their interim and final reports as resulting from their ERC grants.

2 https://erc.europa.eu/sites/default/files/2023-01/Assessing_the_Influence_ERC-funded_Research_Patented_Inventions.pdf

3 A particular thanks goes to Salvatore Torrisi (Vice-Rector for Research Valorisation and Technology Transfer, Professor of Strategic Management University of Milano-Bicocca) and Alfonso Gambardella (Professor of Corporate Management at Bocconi University and holder of an ERC AdG 2021).

4 Final Report Summary INNOS&T https://cordis.europa.eu/project/id/217299/reporting ; Torrisi S., Gambardella A., Giuri P., Harhoff D., Hoisl K., Mariani M. 2016. Used, blocking and sleeping patents: Empirical evidence from a large-scale inventor survey. Res. Policy 47 (7), 1374-1385; Gambardella A. 2023. Private and social functions of patents: Innovation, markets, and new firms. Res. Policy 52 (2023).

It should be noted that the number of projects with self-reported patent applications accounts for between 10% and 13% of ERC-funded projects, while an analysis of non-patent literature citations in patents citing scientific papers acknowledging ERC funding showed that more than 40% of ERC grants generated research that was subsequently cited by patents, indicating a more significant indirect effect on technological progress.

The analysis of the different direct and indirect ways in which frontier research contributes to innovation may have implications for public policy, particularly regarding decisions to provide public funding to (public) research institutions.

The specific questions addressed by the survey described in this document are:

- Does ERC-funded science contribute to the invention process that drives technology progress?
- Do ERC-related inventors/patent applicants make use of their inventions?
- Are these inventions of value?

The Survey

The questionnaire used in the survey and the subsequent descriptive analysis of the results drew inspiration from the InnoS&T project, a FP7-funded initiative that aimed to improve knowledge of the invention process, the incentives and rewards to inventors, and the value of patents. The InnoS&T project covered patent applications filed with the European Patent Office (EPO) with priority dates between 2003 and 2005, listing inventors in 20 European countries, Israel, the US, and Japan at the time of application. The final sample used in that analysis consisted of around 15,000 observations, out of the more than 23,000 responses received in the survey. Notably, Public Research Institutes (PRIs) represented a small percentage of survey respondents.

Table 1: InnoS&T survey - Shares of patent applications by type of applicants based on 20,325 patent applications

Type of applicant (inventor's employer)	Shares (%)
SME	22.9%
Large firms	68.8%
Government Research Organisations	2.6%
Universities and Higher Education	3.9%
Other (Hospital, Foundation, Private Organisations Others)	1.8%

Our analysis draws on the descriptive analysis in Torrisi et al. (2016), which was also based on the InnoS&T survey. The sample in the analysis in Torrisi et al. consisted of 8,144 observations and covered only inventors in private enterprises.

While we recognise that direct comparisons with existing studies can be challenging due to study-specific conditions, we consider the results of the InnoS&T survey as valid and worth comparing to our own findings.

The questionnaire used in the ERC survey is attached as Annex 1. It was sent to 655 unique Principal Investigators (PIs), who had reported around 1,500 patent applications in their projects. We received answers from 184 PIs (28% PI response rate), providing information on 237 different patent applications (15% patent application response rate). The 184 PIs who responded had declared 376 patent applications, so they provided unique answers on 63% of them; however, several PIs explained that their answers covered all their declared patent applications.

The total number of responses (patent applications) used for the analysis is 237. These patent applications originated from 190 ERC-funded projects: 179 main ERC projects (from Starting, Consolidator, Advanced, and Synergy grants) and 11 Proof of Concept (PoC) projects (6% of the total). Of the 179 main ERC projects, 41% were in the Life Sciences (LS), 51% in Physical Sciences and Engineering (PE), 1% in Social Sciences and Humanities (SH), and 1% were Synergy projects.

Overview of the Survey Responses

The Survey provides a comprehensive overview of the key aspects of technology transfer, patenting processes, and commercialisation of research results. It highlights the challenges and successes encountered by researchers in translating scientific discoveries into marketable products and services.

Initial efforts in securing patents often faced obstacles, including high costs and time for patenting, the need for extensive proof of technology viability, and difficulties in attracting investors, particularly for deep-tech ventures. However, the ERC Proof of Concept (PoC) grants often played a pivotal role in bridging the gap between fundamental research and the initial steps of commercial exploitation, enabling researchers to develop prototypes, generate user data, and create spin-off companies.

Collaborations with industry are portrayed as an essential form of strategic alliance in bringing scientific innovations to the market. Examples of partnerships with companies led to significant advancements in areas such as therapeutic antibody development and clinical trials.

The responses to the questionnaire also shed light on the personal journey of researchers as they navigate the complexities of tech-transfer activities. The critical role of institutional support, funding mechanisms, and the entrepreneurial spirit of researchers in driving innovation is underscored.

The prevalence of dormant patents held by ERC grantees indicates challenges in bringing patented inventions to market. This may be due to limited resources dedicated by academic Host Institutions to the economic exploitation of potential innovations. It may also reflect the nature of inventions arising from frontier research projects, which are often early-stage and require time to learn about technological and market conditions before deciding on further development costs.

Results of ERC-funded research, ERC-related start-ups, and inventions patented by ERC PIs are almost all very early-stage outcomes based on scientific knowledge requiring time and additional investment to produce useful innovations. As such, their economic value is not that high, and they are therefore considered not attractive or interesting or ready or de-risked enough for corporates, VCs, and Business Angels.

This raises the question of whether Universities are putting too much emphasis on patents as assets that can be monetised instead of seeing them purely as rights to protect an invention[5], and are therefore pursuing a rent-seeking activity that can have negative effects on the rest of society[6].

The shared experiences highlight the multifaceted nature of innovation, from securing patents and dealing with the intricacies and challenges of commercialisation, to establishing start-up companies and engaging in further tech-transfer activities.

This study shows that ERC funding, besides contributing to the production of excellent scientific research, also contributes to the production of research enabling technological development. Translating these results into actual economic and societal benefits is a challenge that is crucial for the EU's future competitiveness. These stories collectively emphasise the necessity of a supportive system that includes funding, collaboration, and above all a fertile environment conducive to the translation of research into economic and societal benefits.

The results of the survey also show that through these endeavours, and despite all difficulties, some of the researchers funded by the ERC to contribute to advancements in scientific knowledge have also already impacted industry practices, healthcare outcomes, and ultimately, economic development. Some examples are provided below.

5 The licensing and selling of inventions by US universities

6 Demos - The myth of the science park economy

Patent Licensed to an Existing Company

Lori Passmore, Group Leader at the MRC Laboratory of Molecular Biology (MRC-LMB) in Cambridge, has a remarkable research career. She studied Biochemistry at the University of British Columbia in Vancouver (Canada) and later earned her PhD at the Institute of Cancer Research in the UK. Passmore's research focused on eukaryotic translation and cryo-EM, a technique that earned Richard Henderson, her co-advisor, the 2017 Nobel Prize in Chemistry.

Passmore was awarded an ERC Starting Grant in 2011 and an ERC Consolidator Grant in 2017. As a result of her first ERC grant, she filed a patent application that was subsequently licensed exclusively to Quantifoil, a German company specialising in electron microscopy support foils. The ultrastable support grids developed by Passmore and Chris Russo improve microscope image quality, revealing more information than previously possible.

Quantifoil has since manufactured and marketed the gold supports under the brand name UltrAuFoilTMs. This successful collaboration demonstrates the potential for ERC-funded research to be commercialised through partnerships with existing companies.

https://www2.mrc-lmb.cam.ac.uk/golden-grids-for-electron-microscopy-licensed-by-quantifoil/
https://www.quantifoil.com/products/ultraufoil

Patent Sold to an Existing Company

Ron Kimmel, a professor of Computer Science and Electrical and Computer Engineering at the Technion Israel Institute of Technology, has made significant contributions to the field of computer vision. He was awarded an ERC Advanced Grant in 2010 for his project on non-rigid shape reconstruction and deformation analysis.

Kimmel's research has been conducted in collaboration with his colleagues, including Alex and Michael Bronstein, who are identical twin brothers and ERC grantees. They co-founded the Israeli start-up Invision, which developed a coded-light 3D range sensor. The company was acquired by Intel in 2012, and as a result, Kimmel's patented technologies became the foundation of Intel RealSense technology.

For ten years, Kimmel played a leading role in the research and development of Intel RealSense technologies as a part-time senior academic research fellow. Both Bronstein brothers served as Principal Engineer at Intel between 2012 and 2019, contributing to the development of RealSense.

Patent Used to Create a New Company

Juan José Vilatela García has a strong background in Physics Engineering and Materials Science. He founded the Multifunctional Nanocomposites Group at IMDEA Materials Institute in Madrid and was awarded an ERC Starting Grant in 2015 to develop structural energy harvesting composite materials.

Vilatela's ERC Proof of Concept Grant in 2022 proposed a new method for producing high-capacity lithium ion battery anodes made of nanostructured silicon fabrics. The breakthrough technology originated from his ERC Starting Grant and led to the creation of the Madrid-based company Floatech.

Floatech develops high-performance silicon anodes for advanced technology industries.

In November 2023, Floatech secured a funding round of 1.2 million euros led by GROW Venture Partners, aiming to increase the capacity of batteries for electric vehicles. This investment demonstrates the company's intention to become a key player in the sustainable future of electric mobility.

https://floatech.eu/

Fundamental Research in Linguistics Patented to Create a Company

Aditi Lahiri, Emerita Professor of Linguistics at the University of Oxford, has spent many years conducting cutting-edge research in linguistics. She was awarded an ERC Advanced Grant in 2011 and a second Advanced Grant in 2016 for her projects on phonological mental representation and morpho-phonological alternation.

Lahiri was also awarded two ERC Proof of Concept Grants, one in 2015 for a flexible speech recognition system and another in 2019 for integrating morpho-phonology in speech recognition. Using the funding, she and her team developed a patented speech recognition system that can be easily adapted to different speakers, dialects, and languages.

The patented technology was used to create the company Flexsr, which commercialises an innovative speech recognition system that does not require extensive training. This successful collaboration demonstrates the potential for fundamental research in linguistics to be commercialised through innovative applications.

https://flexsr.app/

Main Results from the Survey

The survey reveals several key findings regarding the patenting activities of ERC grantees:

- At the time of patent application, the most important reason for patenting for ERC grantees was licensing, followed closely by direct commercial exploitation.
- In approximately 44% of the cases, ERC grantees declared that they have used their patent applications commercially, either directly, through licensing or selling the patent application, or by creating a start-up. This result is comparable to patent applicants in Public Research Institutions (PRI) in other studies.
- The largest share of patent use by ERC grantees is represented by licensing to independent parties, followed by the creation of start-ups. Notably, ERC grantees tend to license more and create more start-ups than public research institutions in other studies.
- In the majority of cases, the geographical location of the licensee company is the same as the Host Institution (HI) of the ERC grant or a neighbouring country therefore within Europe or an Associated Country. This contrasts with the results of studies[7] examining patent citations of scientific papers acknowledging ERC funding, which show that inventions resulting from ERC science are more likely to be patented by US companies.
- The main reason for not licensing a patent (application) for ERC grantees was that nobody was interested in the licence, likely due to the need for extensive proof of technology viability, as some respondents noted in their comments. In fact, in 68% of the cases, the companies acquiring licences from ERC grantees were founded or co-founded by the ERC Principal Investigator (PI) themselves.
- A very low percentage of patent applications (and lower than for PRI applicants in other studies) were sold by ERC grantees, either because nobody was interested in the acquisition or because the patent was instead licensed, often due to Host Institutions' no-sale policies.
- ERC grantees have a relatively larger share of sleeping patent applications compared to other PRIs in other studies. These are patent (applications) that remain unused for reasons unrelated to block other patents. The analysis of the results confirms hypotheses from other studies on the reasons why large shares of patent applications are left dormant when the inventor is an academic performing fundamental research in a university.

7 ERC science and invention: Does ERC break free from the EU Paradox? - ScienceDirect. These results are confirmed also by the data collected by the experts in the study on "Non-patent literature citations in patents citing scientific papers acknowledging ERC funding" - Munari et al. 2023, although not presented in the published report.

- ERC grantees with a Proof of Concept (PoC) grant show a higher share of used and a lower share of sleeping patent (applications) compared to PIs without a PoC, confirming the role of PoC grants in supporting grantees to realize their academic entrepreneurial project.
- A very large share of patent (applications) filed by ERC grantees are assessed by the respondents as exhibiting a quite high inventive step.
- The survey finds that around 80% of patent (applications) are stand-alone, i.e., not connected to one or more other patents. For the 20% that are connected, the respondents provided the patent numbers of some of the connected patents for further analysis.

Descriptive Analysis

1. Reasons for Patenting

Table 2 presents the average importance of different reasons for patenting at the time of application, scored on a Likert scale ranging from 1 (not important) to 5 (very important).

The results show that licensing ("obtain exclusive rights to license the invention to generate licensing revenues") is the most important reason for patenting for ERC grantees, followed closely by direct commercial exploitation ("obtain exclusive rights to directly exploit the invention economically").

This finding contrasts with the responses from inventors in private companies, as presented in Torrisi et al., which clearly shows that they prioritise direct commercial exploitation as the main reason for patenting, followed by protecting present or future inventions from imitation.

Table 2: Importance of Reasons for Patenting (Average Values)

	Direct commercial exploitation	Licensing	Cross-licensing	Prevention from imitation	Blocking patents	Reputation	Prevention of infringement suits	Pure defence	Technical standards
ERC sample	**3.74**	**4.08**	**1.69**	**3.03**	**2.50**	**3.11**	**1.90**	**2.35**	**2.17**
LS	3.71	4.23	1.64	2.95	2.65	2.89	1.95	2.15	1.98
PE	3.70	4.05	1.76	3.09	2.38	3.26	1.87	2.52	2.30
SH (2 only)	4.50	4.50	1.00	2.50	1.50	4.50	1.00	1.00	1.00
SyG (3 only)	4.33	3.66	2.00	3.00	2.00	3.00	1.00	1.00	3.50
PoC	3.66	3.38	1.38	3.15	2.76	3.08	2.15	2.61	2.16
Torrisi et al.*	**4.73**	**2.96**	**2.69**	**4.13**	**3.83**	**2.85**	**3.16**	**3.39**	**1.92**

*Only patent inventors employed by private enterprises

2. Use of Patent Applications

Table 3 presents the share of different commercial uses of patents and the willingness to use them commercially.

The results show that ERC grantees have used their patent applications commercially in around 44% of the cases. The largest share of patent use is represented by licensing to independent parties, followed by the creation of start-ups.

Notably, when compared with data from the InnoS&T survey, ERC grantees tend to license more and create more start-ups than public research institutions in the sample. However, they make much less direct commercial use of their patents compared to inventors in firms.

Table 3: Uses of patents: share of total patent applications

	Used directly	Willing to direct use	Sold patents	Willing to sell	Licensed	Willing to license	Start-up founded	Willing to found start-up	*Used
ERC sample	22.36%	33.33%	5.08%	17.37%	33.47%	22.03%	26.27%	14.83%	44.30%
InnoS&T PRI	29.61%	45.58%	9.93%	15.56%	23.40%	21.50%	14.42%	10.38%	**(46%)
InnnoS&T Firms	53.33%	23.50%	4.99%	4.45%	6.55%	6.75%	3.23%	1.94%	**(58%)

*Used patents = if the patent has been used in any of the four possible ways in the table (used directly, sold, licensed, start-up).
**Our estimate

3. Unused, Blocking, and Sleeping Patent Applications

As expected, the data from the InnoS&T sample shows that firms have a smaller percentage of unused patent applications and a higher percentage of patent applications filed with the intention to block other patents compared to Public Research Institutions (PRIs). Notably, ERC grantees seem to have a higher motivation to file blocking patents than other PRIs.

Table 4: Different categories of unused patent applications

	Type of non-use as % of total (used + unused)			
	Blocking	Unused	Strategic non-use	Sleeping
ERC sample	25.68%	54.01%	12.16%	41.44%
InnoS&T PRI	16.81%	53.64%	n.a.	36.38%
InnnoS&T Firms	27.13%	41.67%	n.a.	14.53%

- Blocking = if the importance of this reason for patenting was 4 or 5 (see Table 2)
- Unused = if the patent has not been used in any of the four possible ways in the table above (used directly, sold, licensed, start-up) (the count includes "I don't know" or missing in all four).
- Strategic non-use = if blocking was an important reason for patenting (4 or 5) and the patent was unused
- Sleeping patents = if blocking was not an important reason for patenting (importance of blocking was 1, 2, or 3) and the patent was unused.

The analysis of the data reveals that ERC grantees have a relatively larger share of sleeping patents (41.44%) compared to other Public Research Institutions (PRIs) (36.38%). These are unused patents that were not motivated by blocking reasons.

The InnoS&T report suggests that the larger share of sleeping patents held by PRIs compared to firms points out the difficulties of these institutions to bring patent inventions to market and the limited resources usually dedicated to the economic exploitation of innovations. This is likely the case in most of the ERC Host Institutions, which are more oriented towards non-applied research.

In addition, the geographical location of ERC Host Institutions, which are predominantly located in Europe, may also contribute to the higher share of sleeping patents. This is because the tendency of academic institutions to commercialise the results of research is lower in Europe than in other parts of the world.

The InnoS&T report also mentions literature that suggests sleeping patents may be protecting early-stage inventions that need time to learn about technological and market conditions before deciding on further development costs. Other reasons for unused patent applications include:

- The owner could not find an interested licensee or buyer.
- The patent applications are based on scientific knowledge requiring time and additional investment to produce useful innovations.
- They protect inventions arising as an expected or unexpected byproduct of R&D projects.
- Inventions made by inventors whose main activity is not inventing.
- Inventions resulting from pure inspiration or creativity.

These reasons also apply to patent applications in the ERC sample. When asked the reason why they did not use their patent applications for direct commercialisation, 73% of respondents said that it was difficult to turn the invention into a commercial application. When asked why they did not sell their patent applications, 48% of respondents said that nobody wanted to buy it, and 65% said that the patent applications were not licensed because nobody was interested in it.

This is also confirmed by the high percentage of respondents declaring they would be willing to sell, which is similar to that in the PRI group analysed by the InnoS&T study. Other reasons for not using their patent applications mentioned by ERC respondents include:

- A novel technology is always hard to adopt by existing companies.
- Timing (too early in the development).
- Difficult to start clinical trials.
- Commercialisation is not the primary mission or area of expertise of the applicant (research institution).
- Lack of resources.

4. Licensed Patents

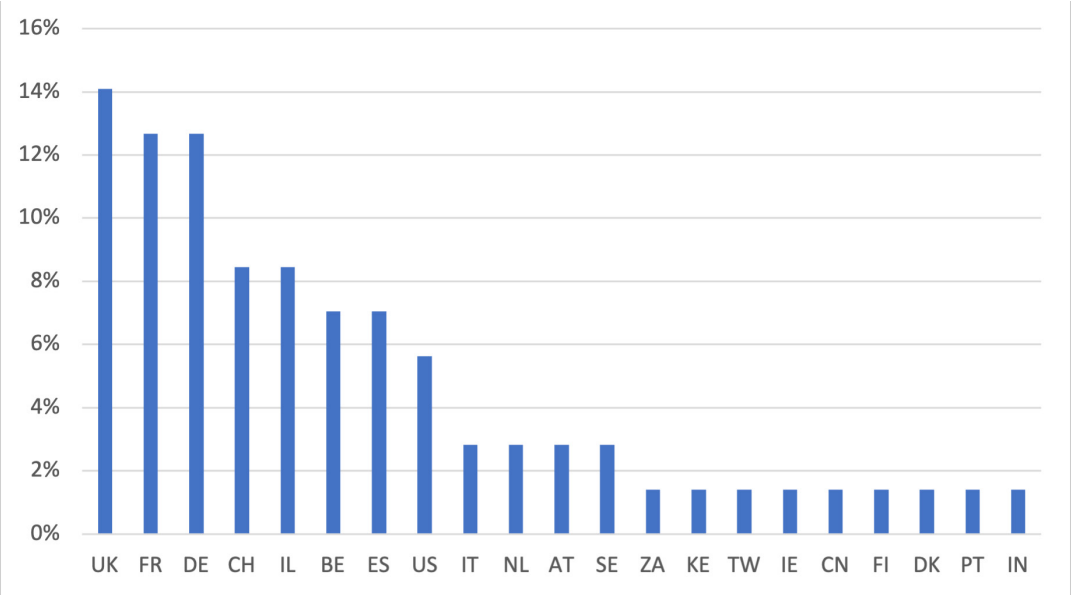
As shown in Table 3, more than 33% of the patent applications from ERC grantees were licensed to third parties. Furthermore, in 22% of the cases, the PI was willing to license their patent application.

In 39% of the cases, the patent application had not been licensed, with the main reasons being that nobody was interested in the licence (49% of not licensed) or that the patent application was filed for non-commercial reasons (17%).

When a patent application was licensed, in 82% of the cases, it was an exclusive licence. The patent applications were licensed to only one company in 90% of the cases, to 2-4 companies in 6% of cases, and to 5-10 companies in 3% of cases.

The 71 companies that received the licences are in the countries shown in Figure 1 below. Nine of them are located outside the EU+Associated countries, with four in the US and one each in South Africa, Kenya, Taiwan, India, and China. In the great majority of cases, the geographical location of the licensee company is the same as the Host Institution (HI) of the ERC grant or in a neighbouring country.

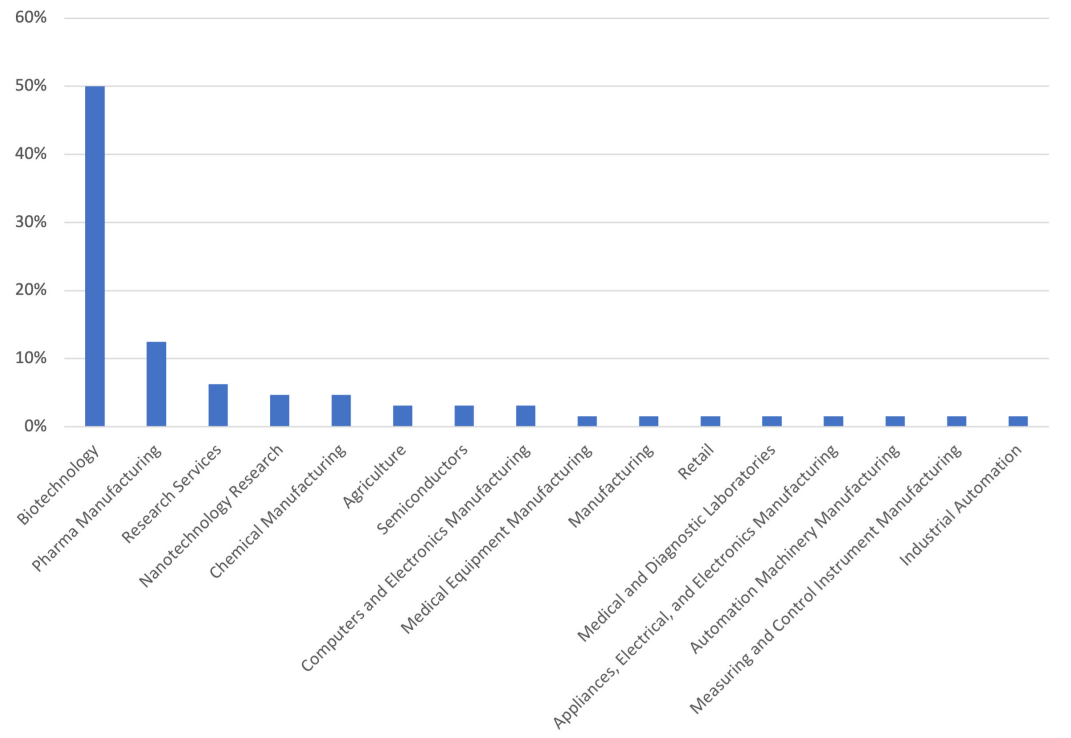
Figure 1: Location of companies that received licences from ERC grantees.



The complete list of the licensee companies is attached in Annex 2.

As can be seen in figure 2, 50% of these companies are in the Biotechnology industry, 13% in Pharmaceutical Manufacturing, 6% in Research Services and the rest scattered in other, mainly hi-tech areas.

Figure 2: Industry of activity of licensee companies



In 68% of the cases, the licensee companies were founded or co-founded by the ERC PI (or were somehow a spin-off of their research). This is interesting to note in relation to some of the comments provided by the respondents, who said that because of the difficulties in finding a company interested in licensing their patent, they decided to create a company themselves and transfer the patent to the newly created start-up.

5. Sale of Patents

As shown in Table 3, in 73% of the cases, the patent applications from ERC grantees had not been sold. The main reasons for not selling the patent applications were that nobody was interested (31% of not sold) or other reasons (34%), which included:

- The patent application was licensed.
- The Host Institution (HI) has a no-sale policy and licenses instead.

In just 5% of cases, the patent application from ERC grantees was sold to third parties. This corresponds to 12 patent applications that were sold, in seven cases to spin-offs of Universities/companies created by the PI and in the other five cases to larger companies (Table 5). This result confirms the non-sale policy of many academic Host Institutions.

The case of patent acquisition from Intel is also emblematic of this tendency. Intel acquired the patent through the acquisition of the start-up Invision, which became the foundation of Intel RealSense technology. The founders of Invision were also ERC grantees working and publishing together with the inventor of this patent.

Table 5: List of companies acquiring patent applications

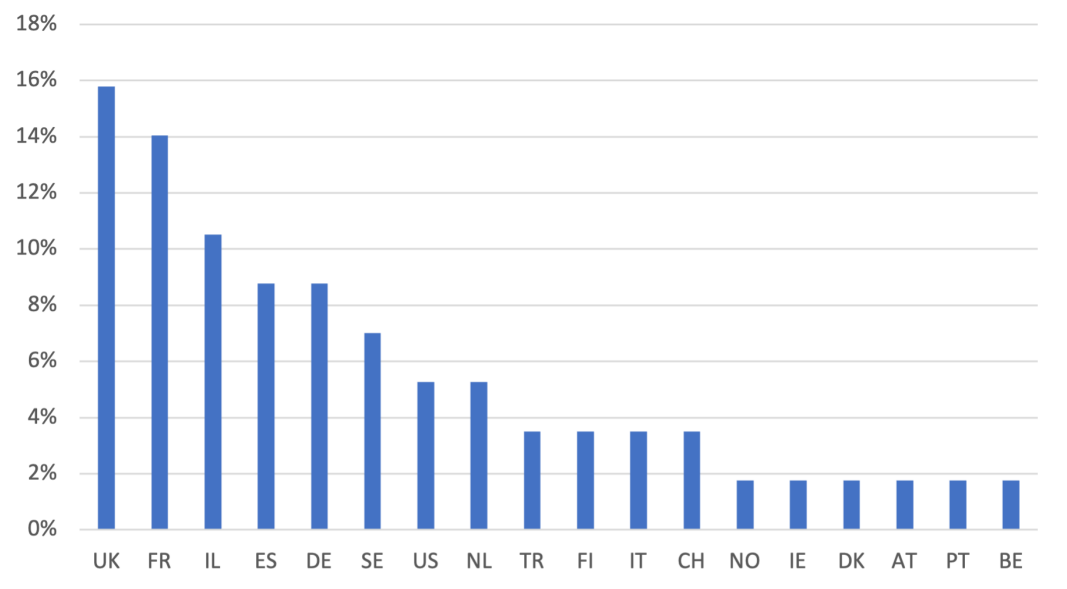
Acquirer of the patent (application)	Geographical location	Comment from the PI selling the patent (application)
University spin-off	Norway	PoC extremely helpful. First PoC generated user data and build a prototype. Second PoC created spin-off that then got EIC-Transition. Product launched
VALO therapeutics (spin-off of the PI)	Finland	VALO has raised significant capital from everywhere in the world, such as Australia and US and has nowadays a big team that is leading the clinical trial.
Umivore AG and Co KG	Germany	
Eindhoven University of Technology	Netherlands	
Merck Darmstadt	Germany	
Intel	Israel	Intel acquired technologies, parts of which developed under the ERC and integrated them into their RealSense products
University (spin off of the PI)	Belgium	
Navinci (founded by the PI)	Sweden	Navinci received several or all the listed patent applications because of my shareholder's agreement. Using variants of these techniques my lab has more recently spun out the company Rarity Bioscience, Vesicode, Readily and SampleFacts.
Veraxa (start-up of the PI)	Germany	
Mintech-Bio (start-up of the PI)	US	To exploit the patent, I had to create a start-up company. It was difficult to get proper support from the University.
Infineon Technologies AG	Germany	
Element Six Ltd	UK	

6. Start-ups

As shown in Table 3, 26% of the patent applications from ERC grantees were used to create a company. Respondents to the survey declared that they used the patent applications to create 57 start-ups, and in 65% of the cases, these new companies were the licensees of the PI's patent applications.

The geographical location of the start-ups only slightly differs from the companies analysed in the section above on licensee companies (Figure 3).

Figure 3: Geographical location of start-ups created by ERC grantees.



7. Use of Patent Applications by PIs with PoC Grants

As explained in the introduction, the 237 patent applications in the dataset resulted from 179 main ERC grants (Starting, Consolidator, Advanced, and Synergy grants) and 11 Proof of Concept (PoC) grants. The main grants in the dataset also originated, at different points in time, 98 additional PoC projects. This, combined with the 11 PoC projects that directly originated patent applications, means that almost 60% of the patent applications in the sample come from inventors who have sooner or later verified the innovation potential of their ideas with an ERC PoC grant.

Table 6: Use of patent application by grantees with and without PoC

								Type of non-use (as % of used+unused)	
Patent applications	Used	Direct use	Sold	Licensed	Start-up founded	Unused	Blocking	Strategic non-use	Sleeping
Applications from PIs with PoC	53%	30%	8%	36%	37%	44%	27%	15%	33%
Applications from PIs with no PoC	32%	12%	1%	29%	11%	67%	23%	14%	53%
All patent applications	44%	22%	5%	33%	26%	54%	26%	12%	41%

The responses to the survey indicate a clear higher share of used patent applications when the inventor also has a PoC in all indicators in the survey. This is also confirmed by the free text comments provided by the respondents to the questionnaire, which recognise that PoC grants played a pivotal role in bridging the gap between fundamental research and commercial application, enabling researchers to develop prototypes, generate user data, and establish spin-off companies.

Previous research has shown that PoC grantees are 13 times more likely to create a start-up than other ERC grantees and 4.5 times more likely to transfer their research results to pre-existing companies. These results confirm once again the great opportunity that PoC grants offer to ERC grantees to realize their academic entrepreneurial project, supporting them in their first steps from idea to exploitation.

8. Granted Patents

A total of 87% of the patent applications covered by responses in the survey were granted (75%) or under evaluation (12%) at the time of the survey. Furthermore, 82% of used patent applications and 70% of unused ones were granted.

The data also shows that:

- 50% of granted patents are used.
- 50% of granted patents are unused.
- 50% of pending patent applications are used.
- 50% of pending patent applications are unused.

It is worth noting that a very small share of patent applications have been used before withdrawal. In fact, the only patent application reported to have been rejected during the granting phase had not been used before refusal.

The data also reveals that 18% of unused patent applications have been withdrawn; only 3% of used patent applications have been withdrawn.

This suggests that the overwhelming majority of patent applications are either used or pending, and only a small minority have been withdrawn.

Table 7: Use of patents: Patent applications vs granted patents

	Used patent applications	Unused patent applications	Total
Granted	85	85	170
	50%	*50%*	*100%*
Pending	14	14	28
	50%	*50%*	*100%*
Rejected	0	1	1
	0%	*100%*	*100%*
Withdrawn	4	22	26
	15%	*85%*	*100%*
Total	**103**	**122**	**225**
	46%	*54%*	*100%*

9. Inventive Step

Following the example of the InnoS&T questionnaire, we asked ERC grantees to provide a subjective assessment of the invention's inventive step. The question is based on the European Patent Office's (EPO) "problem and solution approach". According to this approach, an invention involves an inventive step if it is not obvious to the skilled person in the light of the state of the art, which is a prerequisite for a granted patent.

In essence, the question asks whether the solution presented to the problem in the patent application is obvious or not to the person skilled in the art.

The answers from the survey are illustrated in Table 8. The average individual assessment of the inventive step on a Likert scale varying from 1 (extremely high) to 5 (very low) is quite high, with an average value of 1.78. More than 81% of the respondents gave it a value of 1 or 2, indicating a high level of innovativeness.

Only 3% of the respondents were unable to assign a value, which suggests that the vast majority of ERC grantees are confident in their ability to assess the inventive step of their patented inventions.

Table 8: Inventors' Assessment of the Innovativeness of their Patented Invention

Inventive step	*Average scale 1-5 scale (1 =extremely high)	1-2 (share of responses)	Don't know (share of responses)
ERC sample	1.78	81.74%	3%

The InnoS&T report references an earlier paper from the same authors that found a positive relationship between the inventive step in inventions and the educational attainment of contributing inventors. Additionally, the authors hypothesize that the inventive step of inventions filed by commercial organizations is lower than that of inventions filed by other types of organizations. This is because commercial organizations typically have more experience in patenting, maintain larger portfolios, and engage in stronger commercialisation activities than non-private organizations.

As a result, private organizations may file applications for inventions with smaller marginal inventive steps compared to other types of organizations.

The high level of education among ERC grantees and the fact that their employer is not a private commercial organization seem to confirm these hypotheses. The ERC grantees' high level of education suggests that they possess the necessary expertise and knowledge to create inventions with high inventive steps. Furthermore, the fact that their employer is not a private commercial organization implies that they may be less constrained by the commercialisation pressures that can lead to lower inventive steps in inventions filed by commercial organizations.

These findings suggest that ERC grantees are well-positioned to create inventions with high inventive steps, which can drive innovation and economic growth.

10. Technically Connected Patents

The InnoS&T report highlights the concept of technically connected patents, where multiple patents can cover different inventions that are part of the same broad invention. They also note that patents can be technically connected in various ways, such as through technical complementarities across patented inventions or through technical interdependence that reinforces protection.

We asked the same question in our survey to identify a group of technically interconnected inventions that are part of an innovation. This will allow us to further study and analyse the influence of ERC-funded research on the development of an innovation.

The InnoS&T survey found that nearly 60% of patents are stand-alone, while the remaining 40% are technically connected to one or more patents. Our survey found that 20% of the patent applications in the dataset are connected to other patented inventions. Specifically, 34% of these connected patents are linked to 1-2 other inventions, 60% are linked to 3-5, and 6% are linked to 6-10.

The respondents also provided the patent number of some of these connected patents, which will form the basis for further analysis aimed at tracing the contribution of ERC-funded knowledge to the development of key innovations.

Acknowledgments

We acknowledge colleagues from the ERCEA Unit A1 Ludmila Oliveriusova, Anna Pelagotti and Vladan Arsenijevic for their work on this analysis, which was led by Laura Pontiggia from the same Unit.

We would like to thank Sylvie Lorente, member of the ERC Scientific Council and Chair of the ERC Working Group on innovation, for her guidance in developing the main research question and her support leading up to the publication of this report, together with the other members of the Working Group (Geneviève Almouzni, Dirk Inzé, Ben Feringa, Maria Leptin, Luke O'Neill, Milena Žic Fuchs).

ANNEX 1 – Questionnaire
Survey to ERC grantees who declared a patent application as a result of their ERC-funded research

Dear ERC grantee,

This questionnaire is intended for ERC grantees who declared one or more patent applications as a result of their ERC-funded research.

Please find the survey's data protection notice here: dpn-for-surveys-patent-use.pdf

Notice:

In all of the following questions, the term “the invention” will always refer to a particular patent application of yours. You have received information on the specific patent application in our email message inviting you to participate in this survey.

If you have declared to the ERC more than one patent application, you can find reference to all of them in our email message. In that case, please **fill-in one questionnaire per patent application by re-opening each time the same link that was provided in the email message.**

All information and data collected will be kept strictly confidential and disclosed only in an aggregated manner, unless we seek and obtain your explicit authorization for specific cases.

In answering this questionnaire, please always refer to this particular patent application.

Name of the Inventor PI:

Patent application ID (as in our email message inviting you to participate in this survey)

Title of Patent Application:

Year of filing the patent application:

Please list below the patent Applicant(s):

A. Reasons for patenting

How important were the following reasons for patenting this invention at the time when the patentapplication was filed?

Commercial use:

	1 (not important)	2	3	4	5 (very important)
Commercial exploitation (obtain exclusive rights to directly exploit the invention economically)	○	○	○	○	○
Licensing (obtain exclusive rights to licence the invention in order to generate licensing revenues)	○	○	○	○	○
Cross-licensing (improve your bargaining position in the trading of your own patent rights in exchange for other firms' patent rights)	○	○	○	○	○

Reasons different from commercial use:

	1 (not important)	2	3	4	5 (very important)
Prevention from imitation (protect present or future inventions by patenting the “findings around”)	○	○	○	○	○
Blocking patents (avoid that others patent similar inventions, complements or substitutes)	○	○	○	○	○
Reputation (patents as an element of evaluation of the inventors/research unit)	○	○	○	○	○
Prevention of infringement suits (build a credible threat such that your organization can sue others if they sue your organization)	○	○	○	○	○
Pure defence (ensure that the use of own technology is not blocked by others)	○	○	○	○	○
Technical standards (protect an invention that might be useful as part of a technical standard)	○	○	○	○	○
Other (please specify)	○	○	○	○	○

B. Direct exploitation of the patent

Have the applicant(s) or affiliated parties ever directly exploited this invention commercially, i.e., in a product, service or in a manufacturing process?

- Yes
- No
- Not yet, but still investigating the possibilities
- I don't know

If Yes, please provide the name of the product, service or manufacturing process:

If No, because...

- It was difficult to turn the invention into commercial application
- The invention cannot be turned into a commercial application.
- Other reasons (please specify):

C. Patent sale

Was the ownership right to the patent sold to another party not related to the original owner(s) or applicant(s)?

- Yes
- No
- No, but willing to sell
- I don't know

If Yes, could you provide the name of the party who bought the patent?

In which country is that party located?

If No, because...

- Nobody wanted to buy it
- The patent application was filed for other reasons
- Other reasons (please specify):

D. Licencing

Has this patent been licensed by (one of) the patent-holder(s) to a third party?

- Yes
- No
- No, but willing to license
- I don't know

If Yes, Was this an exclusive licence?

- Yes
- No

How many parties (roughly) have obtained a licence?

- Only one
- 2-4
- 5-10
- 11-50
- More than 50
- I don't know

Could you provide the following information on the parties that received the licence?

	Name of the party obtaining the licence	Geographical location	Involvement of the ERC PI in the creation of this third party (Yes/No)
1			
2			
3			
4			
5			

If No, because...

- Nobody was interested in the licence
- The patent application was filed for other reasons
- Other reasons (please specify):

E. Start-up

Has this patent been used by any of the inventors or applicants to found a new company?

- Yes
- No
- No, but creating a company is under consideration
- I don't know

If Yes, please provide the name of the company:

Please, provide the location of the company:

Please provide the website of the company:

If No, because...

- The creation of a company was not considered the best way to commercialise
- The patent application was filed for other reasons)

F. Was this patent ever litigated in a court? (By litigation, we mean court proceedings other than opposition or appeal at a Patent Office)

- Yes
- No

G. Inventive step

According to the European Patent Convention, an "**inventive step**" means that the invention (the solutionpresented to the problem) is not obvious to a person skilled in the art.

We would like to know how you would rate the degree of the inventive step of the invention described at thetime of the application.

	1 (Extremely high)	2	3 (Average)	4	5 (Very low)	Don't know
Inventive step						

H. Did the invention build in a substantial way on other inventions that you knew?

- Yes
- No
- I don't know

I. Patents can be technically connected, and more patents can cover different inventions that are part of the same broad innovation. Was the patent in question part of a group of patents which crucially depend on each other in a technical way?

- Yes
- No
- I don't know

J. Please indicate how many patents were part of the group of patents

- 1-2
- 3-5
- 6-10
- 11-20
- >20
- I don't know

K. Would you be able to list some of the patents in this group of patents

	Patent application number or Patent number	Patent (or patent application) title
1		
2		
3		
4		
5		
6		
7		

L. Has the patent been granted?

- Yes
- No

If Yes, in which countries was it granted?

If No, because

- It is still under evaluation
- It was withdrawn
- It was rejected (please specify for which reason)

M. Would you like to add anything about your experience in relation to the pathway from frontier research to invention and towards innovation?

For example:

• Was the pathway followed by you in relation to this invention useful?

• Did you encounter some particular issues you would like to mention?

• Do you feel that your research and your work contributed to the development of innovation in other ways than through patenting?

• Are you involved in any other patents/inventions/start-up/tech-transfer activities, beyond those related toprojects funded by the ERC?

Annex 2 - List of licensee companies

Name of the party obtaining the licence	Geographical location
A2PS	France
Aelin Therapeutics	Belgium
Agriculture Division of South African	South Africa
Anagenesis Biotechnologies	France
Cambridge Graphene	UK
CD3	Belgium
Charity	Kenya
Cambridge Raman Imaging	UK and Italy
Crocus Technology	France and USA
DNAlytics	Belgium
Dolomite	UK
Dynacure	France
Eline Medical	Taiwan
Esocap	Switzerland
EssilorLuxottica	Italy/France
Exhaura	Dublin
Floatech	Spain
GrandVision	Benelux
Heqet Therapeutics	UK
HydRegen	UK
ILTOO pharma	France
InFlectis BioScience	France
InnoventBio	China
JaxBio	Israel
Lesa-Technology	Geneva
Lexogen	Austria
Liposphere	Israel
Mecwins	Spain
Merck Darmstadt	Germany
Mintech-Bio	USA
MOAB	Italy
Momentous Therapeutics	UK
Nanoimmunotech	Spain
Navinci Diagnostics	Sweden
NESTE CORPORATION	Finland
Newcells Biotech	UK
Nireos	Italy
NMR-Bio	France
Novartis	Switzerland
NVision Imaging Technologies	Germany
Oxcia	Sweden
Oxford Nanoimaging	UK

Oxford Nanopore Technologies	UK
Peptomyc	Spain
Plantae Bioscience	Israel
Qfactory	Denmark
Quantifoil	Germany
QUANTRO Therapeutics	Austria
RYAPURTECH	Portugal
Smart Small Satellite Systems	Germany
Scala Biodesign	Israel
Seenergi	France
Serum Institute of India	India
Siemens	Germany
Simabs	Belgium
Smart Immune	France
Squal Pharma	USA
Synhelion	Switzerland
Synple Chem	Switzerland
SynSense	Switzerland
TELOMERE THERAPEUTICS	Spain
TeraNova	Netherlands
Tissue Dynamics	Israel
Topokine	USA
Trince	Belgium
Trobix Bio	Israel
Ultraleap	UK
Umicore	Germany
VERAXA Biotech	Germany
Visevi Robotics	Germany
Zentrum für Telematik	Germany

https://erc.europa.eu/