The role of European public research in patenting and innovation

An in-depth analysis of the patenting activities of European public research organisations and research hospitals at the EPO

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Foreword

Public research is one of Europe's greatest strengths. Alongside universities, public research organisations (PROs) and research hospitals play a crucial role. From large multidisciplinary institutes, such as France's National Centre for Scientific Research (CNRS) or Germany's Fraunhofer-Gesellschaft, to specialised applied research centres, PROs have long shaped scientific progress and driven technological advances. In the European Union alone, they now employ over 350 000 researchers. Research hospitals are equally vital, converting discoveries into new drugs, diagnostics and medical technologies that safeguard the health of Europe's citizens while reinforcing some of its most competitive industries.

Today, as Europe seeks to become more competitive, these institutions are again in the spotlight. Policymakers increasingly view public research as key to Europe's future – a view reflected in the EU Startup and Scale-up Strategy. And patents are central to this, transforming scientific breakthroughs into assets that attract investment, power startups and maximise impact.

This study is the first comprehensive mapping of PRO and research hospital patenting across Europe. With almost 63 000 European patent applications over two decades, these organisations have emerged as central players in Europe's innovation system. They specialise in fields from life sciences to advanced engineering and contribute directly to the creation of successful startups. Yet their roles vary considerably across countries, and cross-border collaboration is still limited. Further integration – Enrico Letta's idea of a "fifth freedom" for research and innovation – is essential. The introduction of the European Unitary Patent as a tool to foster wider circulation of knowledge and more effective commercialisation across the continent is another step towards achieving this.

The study also serves as another milestone for the EPO's Observatory on Patents and Technology. Since its creation in 2023, the Observatory has focused on public research and technology transfer, most notably with our analysis of European universities and their patent activities in a study launched last year. We also developed the Deep Tech Finder, an interactive tool linking European patent data with business information to connect European universities, startups … and now PROs.

The Observatory's work is grounded in collaboration. For this study, experts from the national patent offices of 24 EPO member states contributed: Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Cyprus, Czech Republic, Germany, Estonia, Spain, Finland, France, Greece, Croatia, Italy, Luxembourg, Latvia, Monaco, the Netherlands, Poland, Portugal, Slovenia, Slovakia, Türkiye and the United Kingdom.

Leading organisations also played a vital role: Fraunhofer ISI as main partner; European Association of Research and Technology Organisations (EARTO); other major PROs, such as the Spanish National Research Council (CSIC), the CNRS, the French Alternative Energies and Atomic Energy Commission (CEA) and the Netherlands Organisation for Applied Scientific Research (TNO); the Association of European Science and Technology Transfer Professionals (ASTP). Their contributions, from exchanges on the findings to providing case material, underline the shared commitment to growing the evidence base for policy and practice.

The findings presented here highlight both the achievements and the untapped potential of public research. They also point to the challenges ahead: strengthening the role of PROs across borders, making it easier to commercialise their products, and ensuring that the European patent system is used to its full potential.

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List of abbreviations

EARTO	European Association of Research and Technology Organisations
EP	European patent
EPO	European Patent Office
HEI	Higher education institution
IP	Intellectual property
PROs	Public research organisations
R&D	Research and development
TTO	Technology transfer office

List of countries

AL	Albania
AT	Austria
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
CH	Switzerland
CN	People's Republic of China
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
ME	Montenegro
MK	North Macedonia
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RoW	Rest of world
RS	Serbia
SE	Sweden
SI	Slovenia
SL	Slovakia
SM	San Marino
TR	Türkiye
UK	United Kingdom
US	United States

Member states of the European Patent Organisation that are not part of the EU27: AL, CH, IS, LI, MC, ME, MK, NO, RS, SM, TR, UK.

Executive summary

This study, undertaken by the EPO's Observatory on Patents and Technology, extends the Observatory's 2024 analysis of university patenting to encompass public research organisations (PROs) and research hospitals across all 39 EPO member states. By adopting the academic-patent methodology, tracking applicants as well as inventors, it captures the true innovation footprint of European PROs, universities and research hospitals. Direct academic patents are European patent applications filed by the research institution, while indirect academic patents occur when researchers from these institutions are named as inventors on European patent applications filed by industry or other entities.

This project builds on the policy imperatives set out in the Letta and Draghi reports which called for deeper integration of Europe's research systems, stronger cross-border collaboration, and tighter links between public research and industrial innovation. It also draws on the European Commission's recent EU Startup and Scale-up Strategy, which emphasises the need to make Europe more attractive for technology-driven ventures by improving regulatory frameworks, access to finance and support for research commercialisation.

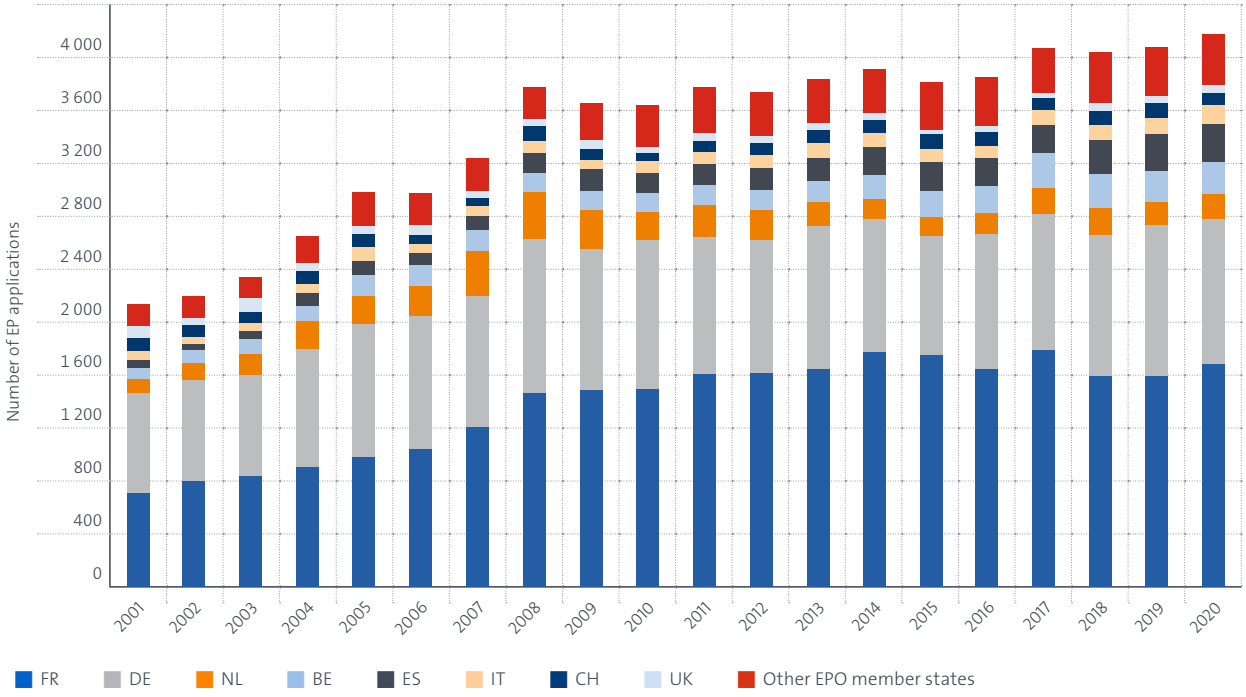
Developed in close co-operation with Fraunhofer ISI and support from experts from 24 national patent offices, the study offers both quantitative metrics and contextual insights, reinforcing its relevance for stakeholders across Europe. Firstly, it provides a detailed assessment of PRO contributions to EPO patenting activity through both direct academic patents and filings where PRO researchers are only listed as inventors. Secondly, it benchmarks the patenting activity of PROs against universities and research hospitals in Europe by comparing patent volumes, temporal trends and the ratio of direct versus indirect filings, thereby illuminating differences in institutional strategies and collaboration models. Thirdly, it evaluates these institutions' roles in European research integration and the broader innovation ecosystem by analysing co-applicant collaborations with industry, cross-border partnerships and links to startup creation and technology transfer.

Key findings

1. European PROs contributed to almost 63 000 European patent applications between 2001 and 2020, yet play vastly different roles across national innovation landscapes

Figure E1

Trend in PRO-related patent applications at the European Patent Office, 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

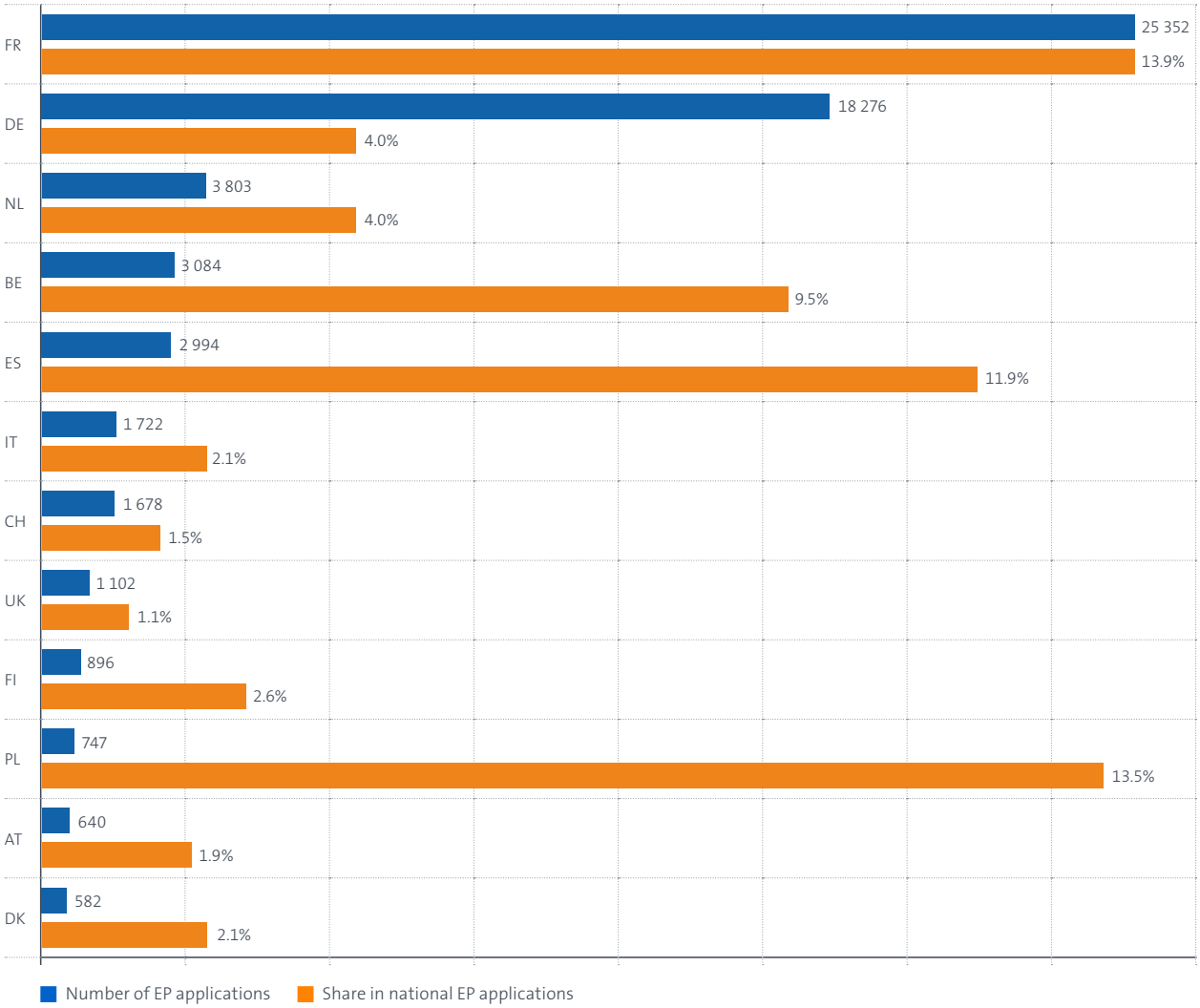
European PROs demonstrate substantial contributions to patenting activity, with nearly 63 000 patent applications at the EPO involving PRO as applicants or their researchers as inventors between 2001 and 2020, representing 4.9% of all patent applications with European applicants. PRO-related academic patents are highly concentrated and specialised in science-based technologies – particularly biotechnology and pharmaceuticals, which together account for 27.6% of all PRO-related academic patents – but also in measurement, semiconductors, and computer technology. However, in the most recent period 2016-2020, a technological rebalancing can be observed, with life sciences maintaining dominance, while specialisation in telecommunication and digital communication has increased.

PRO patenting activity in Europe exhibited rapid growth during the 2000s that outpaced overall European patenting (rising from 1 950 European patent applications in 2001 to 3 450 in 2008, or from 3.6% to over 5.4% of all European patent applications), followed by stabilisation above 5% after the global financial crisis, and ultimately reaching a peak of 3 815 EP applications in 2020. However, these aggregate statistics hide major differences between countries, highlighting the heterogeneous role of PROs within different European innovation ecosystems. While France leads in absolute PRO patent volumes (25 352) followed by Germany (18 276), the strategic importance varies significantly across countries – France, Spain, Poland and Belgium show PRO contributions between 9% and 14% of national patent output, whereas Germany and the Netherlands maintain PRO shares at 4% despite substantial absolute volumes. Co-filing patterns vary also considerably across countries.

France and Spain show high multi-applicant rates for their academic patents, with multiple universities, PROs, and research hospitals frequently appearing as co-applicants, while Germany and the UK display lower multi-applicant rates, with academic patents more commonly filed by single institutions. These differences reflect varying institutional collaboration frameworks and distinct national practices regarding patent ownership structures.

Figure E2

Number of PRO-related EP applications for the top European countries and their shares in national EP applications in the period 2001-2020

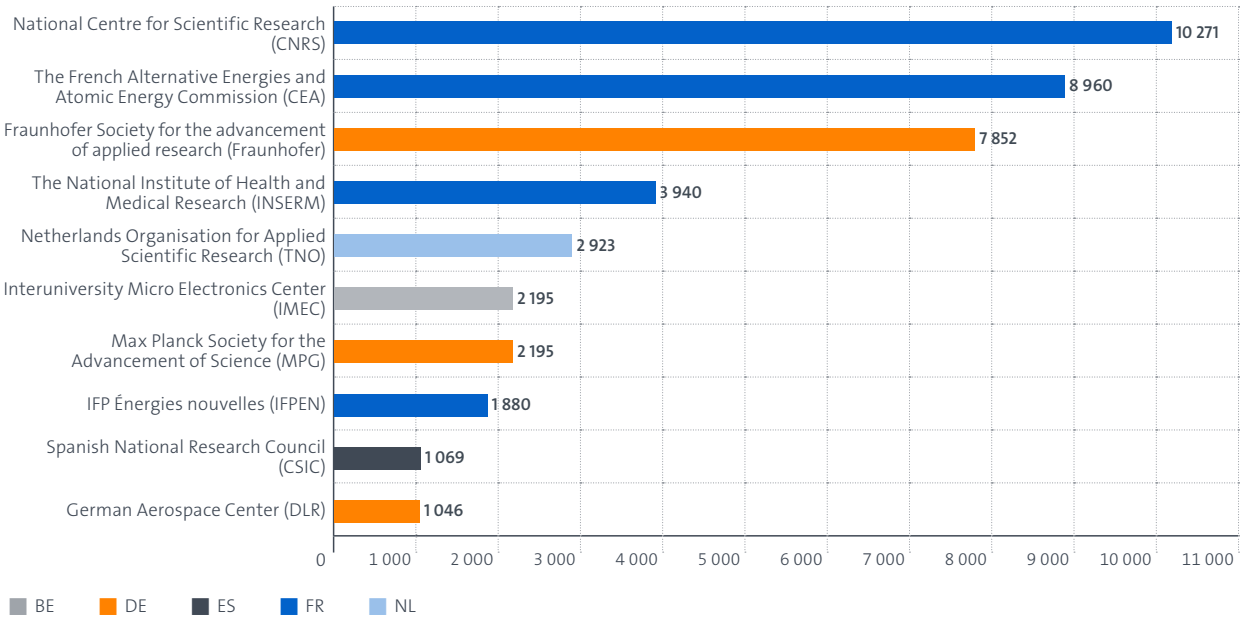


Source: EPO - PATSTAT, Elsevier Scopus

2. A small number of leading European institutions account for most PRO-related academic patenting.

Figure E3

Contributions of leading European PROs to academic patents at the EPO, 2001-2020



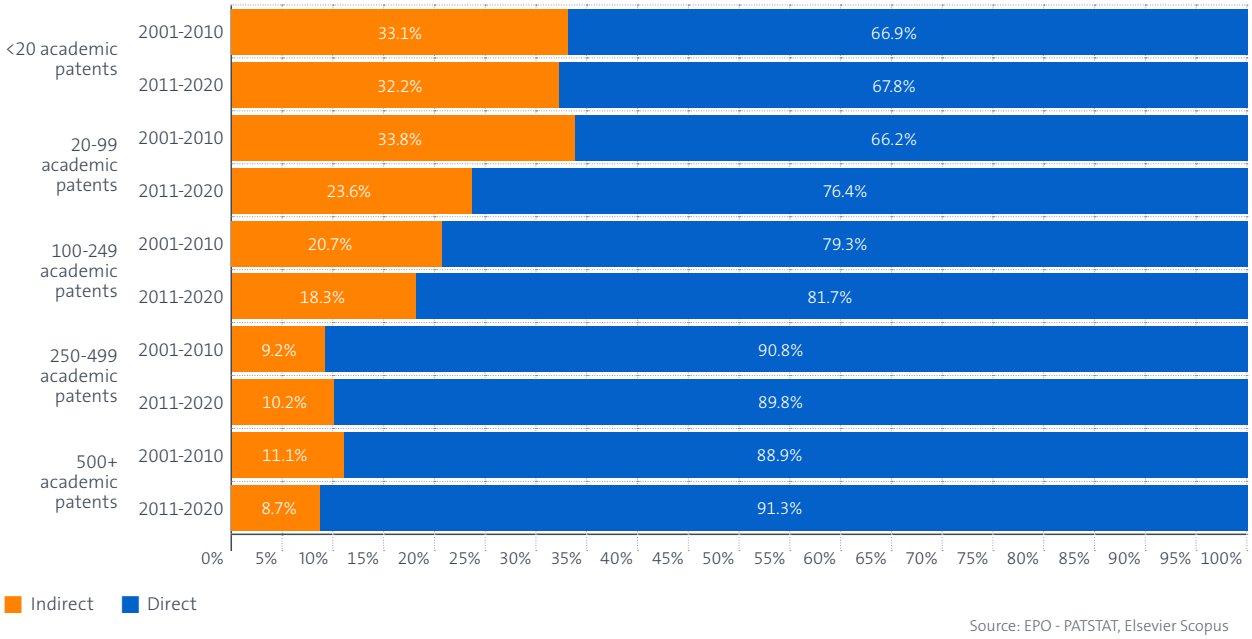
Source: EPO - PATSTAT, Elsevier Scopus

The top ten European PROs stand out with nearly two-thirds (63%) of all PRO-related academic patents between 2001 and 2020. These institutions include four French, three German, one Dutch, one Belgian and one Spanish institution, led by France's CNRS (10 271 applications), CEA (8 960) and Germany's Fraunhofer Society (7 852). While all of them have a major impact on innovation ecosystems, they show different positions in the innovation value chain with differing institutional mandates and national innovation strategies. Computing EP patent applications-to-STEM publication ratios for these ten PROs reveals that institutions with basic science orientation like Max Planck Society, CNRS, INSERM and CSIC maintain lower ratios in line with their research missions. By contrast, application-oriented organisations such as CEA, Fraunhofer, TNO and IMEC exhibit relatively high EP patent applications-to-STEM publication ratios, thus signalling closer proximity to market. Notably, French PROs have shown upward momentum in their ratios, while German organisations have generally experienced flat or declining trends.

In general, European PROs show distinct patterns in patent filing approaches and technology focus that vary not only by country, but also systematically with organisational size. The data reveal that smaller PROs maintain higher proportions of indirect patent filing and tend towards concentrated technology portfolios in specific domains. They typically focus on specific technological domains where concentrated expertise and resources can yield competitive advantages, which may reflect their participation in local industry ecosystems and regional innovation partnerships. Larger PROs demonstrate higher rates of direct patent filing and appear to contribute to more diversified patent portfolios across multiple technology domains, while medium-sized organisations exhibit characteristics that fall between these patterns, suggesting different organisational approaches to technology development and commercialisation within the European research landscape.

Figure E4

Share of direct (blue) and indirect (orange) academic patents by PRO size group and time period (2001-2010 vs 2011-2020)

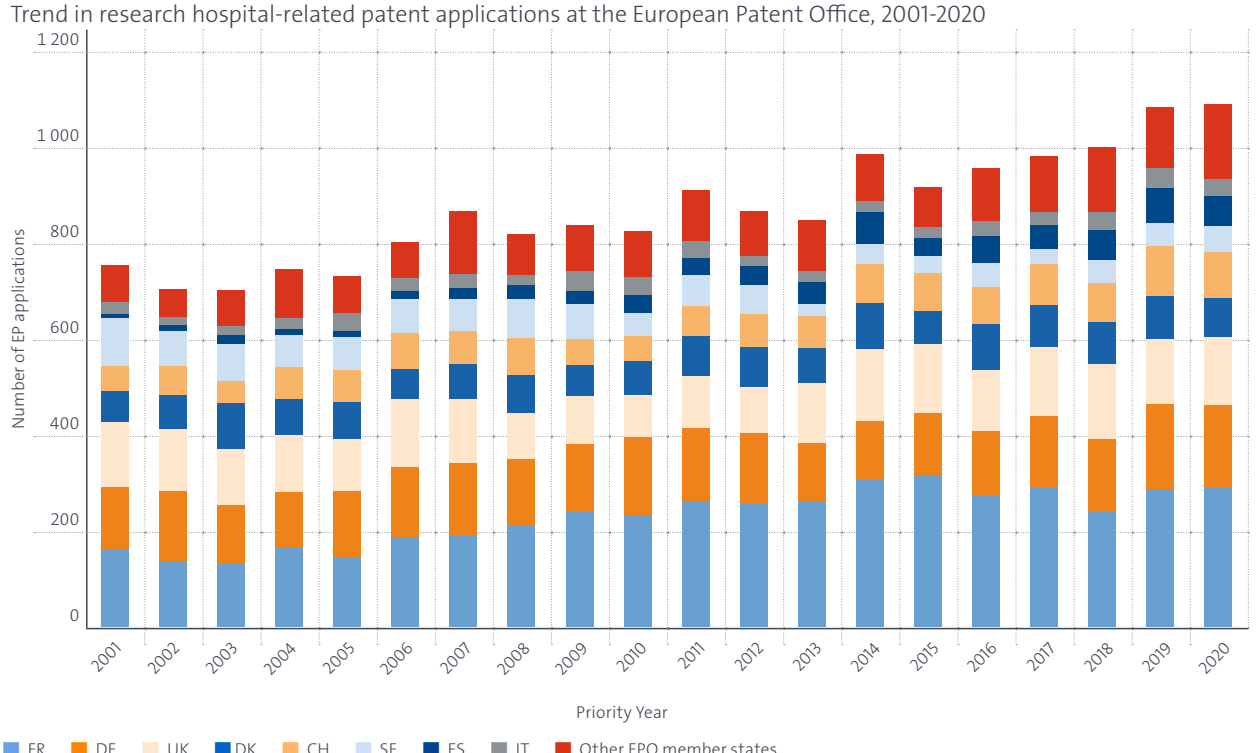


Source: EPO - PATSTAT, Elsevier Scopus

3. European research hospitals drive over 17 400 EP applications with concentration in four core medical research fields

Figure E5

Trend in research hospital-related patent applications at the European Patent Office, 2001-2020



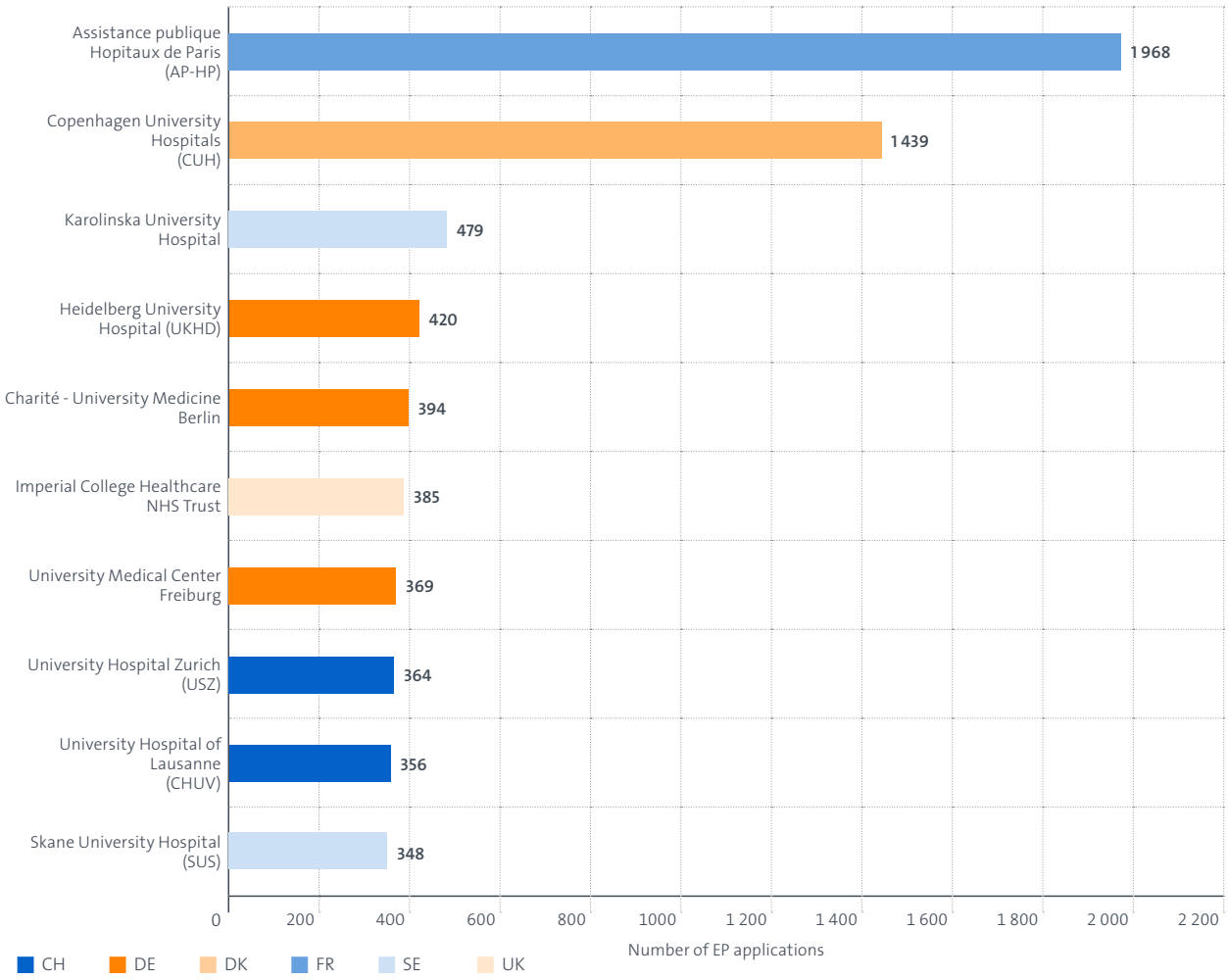
Source: EPO - PATSTAT, Elsevier Scopus

European research hospitals contributed to 17 434 EP applications between 2001-2020, demonstrating sustained growth from 700-750 applications in the early 2000s to nearly 1 100 in 2020, with indirect applications dominating. France leads the landscape with 4 575 applications, followed by Germany (2 858) and the UK (2 500), collectively representing over 56% of all research hospital academic patents, while Assistance Publique Hôpitaux de Paris (AP-HP) alone accounts for 1 968 applications between 2001 and 2020; or over 11% of the European total.

Research hospitals exhibit extreme technological specialisation, with almost 90% of patents concentrated in just four fields: pharmaceuticals (31.3%), biotechnology (25.4%), medical technology (24.0%) and analysis of biological materials (8.4%). This concentrated profile reinforces their role as specialised medical innovation hubs within the European research ecosystem, distinct from the broader PRO landscape that shows greater technological diversification.

Figure E6

Contributions of leading European research hospitals to academic patents at the EPO, 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

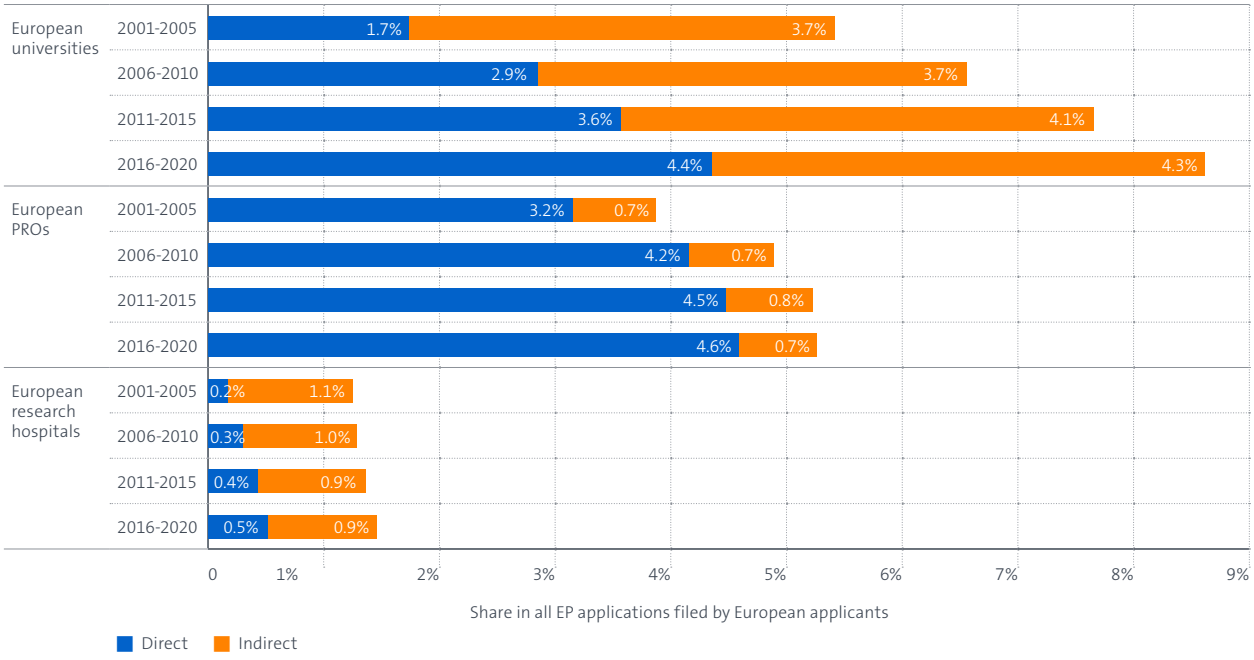
4. European research institutions shift from indirect to direct patent filing as universities drive academic patent growth, with consistent contributions from PROs and research hospitals

European research institutions combined contributed to almost 137 000 EP applications between 2001-2020, with total involvement growing 87.8% from 4 628 in 2001 to 8 691 in 2020. This growth in academic patenting was primarily driven by universities, achieving 129.2% expansion between 2001-2020 while PROs (95.6% growth) and research hospitals (44.5% growth) demonstrated a more modest surge. PRO contributions to total European academic patenting stabilised around 44-47% and research hospital shares remained steady at approximately 12-14%, while the share of university-related academic patents surged.

The growth trajectory across all three institution types is fundamentally driven by direct patent filing rather than indirect academic patents. PROs maintained consistently high direct filing preferences throughout the period, increasing from 3.2% in 2001-2005 to 4.6% in 2016-2020 while indirect contributions declined, resulting in direct-to-indirect ratios rising from 4.4 to 6.9. Research hospitals, while remaining predominantly indirect contributors (0.9% vs 0.5% direct in 2016-2020), showed the strongest growth in direct filing, increasing their direct-to-indirect ratio from 0.16 to 0.55. This reflects their gradual shift towards institutional patent ownership while maintaining collaborative roles. At the same time, universities transformed from predominantly indirect contributors (3.7% vs 1.7% direct in 2001-2005) to balanced participants (4.4% direct vs 4.3% indirect by 2016-2020), even overtaking European PROs as the largest direct patent filers in 2020.

Figure E7

Share of direct and indirect academic patents of European universities, PROs and research hospitals as percentage of EP applications from European applicants by five-year periods



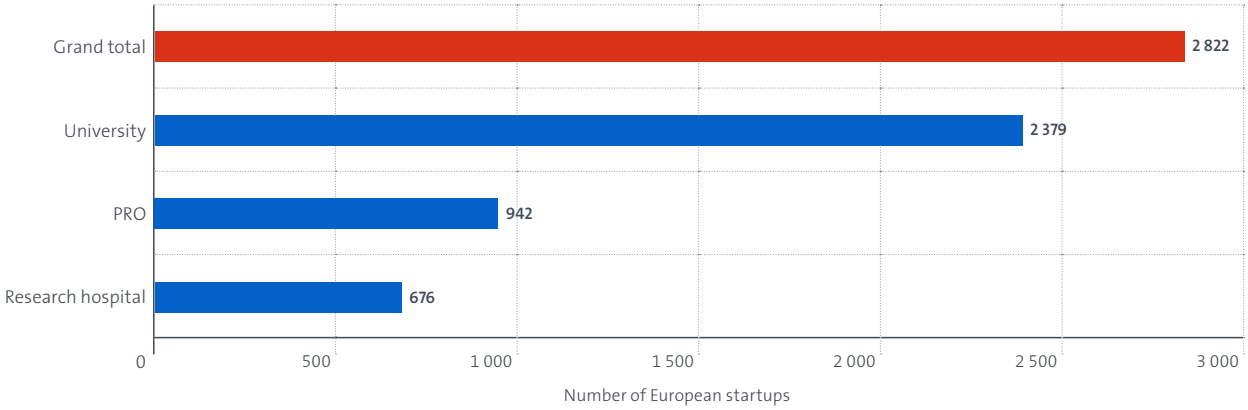
Source: EPO - PATSTAT, Elsevier Scopus

The most significant commonality between PROs and universities lies in their convergent biotechnology (14.3% PRO vs 14.9% universities in 2001-2020) and pharmaceutical (13.3% vs 16.2%) specialisation, indicating these fields represent a fundamental strength across European academic research. In contrast, PROs concentrate more heavily in advanced instrumentation and physical sciences (semiconductors, measurement technologies, optics), while universities maintain stronger positions in medical applications and certain chemical domains. Over time, the most important divergent trend involves digital technologies, where PROs achieved noticeable gains, whereas universities advanced significantly in environmental technology, suggesting distinct strategic responses to emerging technological priorities.

5. Over 2 800 European startups linked to research institutions attract disproportionate investment and drive technology commercialisation

Figure E8

European startups with EP applications linked to European research institutions



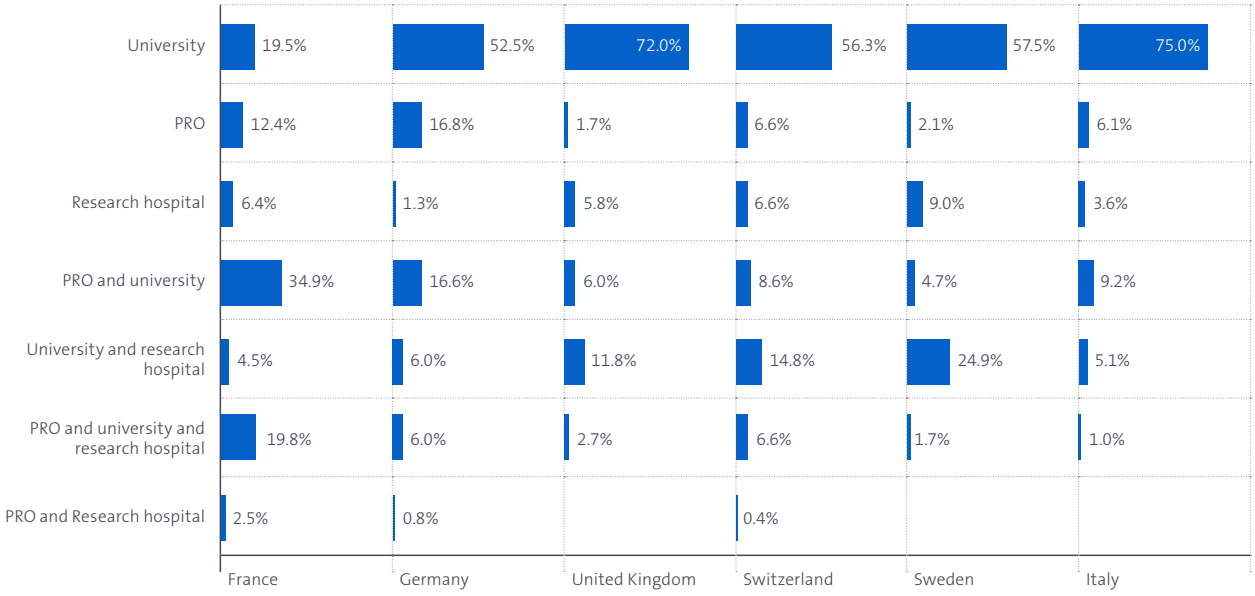
Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

Out of all identified startups that have filed at least one European patent application, 27.2% have inventors linked to European research institutions (universities, PROs or research hospitals). This corresponds to over 2 800 European startups. At the country level, France (550), the UK (414) and Germany (398) host the largest numbers of such patenting startups. Sector-wise, healthtech dominates, representing more than 50% of all startups, followed by energy (8.2%), information technology (8.2%) and computer hardware (7.1%), which aligns with the technology profiles of European academic patents.

Most of these European startups are connected to universities (2 379, or 84.3%), with PROs (942) and research hospitals (676) playing important but smaller roles. However, a closer look at the co-applicant behaviour reveals distinct national collaboration patterns for European startup-research linkages. France demonstrates the most diversified approach with less than 20% of startups tied exclusively to universities and over 60% engaging in multi-institutional partnerships (34.9% PRO-university, 19.8% involving all three institution types). In contrast, the UK (72 %) and Italy (75%) exhibit university-centric models with minimal institutional diversity. Sweden uniquely emphasises university-research hospital connections (24.9%), while Germany (52.5% university-only) and Switzerland (56.3%) occupy intermediate positions with moderate multi-institutional engagement, suggesting different national innovation ecosystem structures and collaboration preferences.

Figure E9

Distribution of European startups with EP applications by research institution relationship patterns for the top six European countries



Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

Despite making up just over a quarter of all identified patenting startups in Europe, these research-linked startups accounted for a far greater share of startup success between 2021 and 2024: 50.3% of total funding raised, 30.6% of all funding deals and 30.9% of all successful exits. This evidence highlights that startup creation has become a critical pathway for bringing European research inventions to market, validating policy efforts aimed at fostering deeper academic engagement in innovation.

Table E1

Comparison of Deep Tech Finder (DTF) indicators among European startups with EP applications based on data from 2021-2024

	Number of startups	Number of deals	Total funding	Net jobs created	Number of exits
DTF startups with links to European research institutions	2 822	2 049	€58.97 billion	16 830	172
Share of all DTF startups (in %)	27.2%	30.6%	50.3%	26.9%	30.9%

Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

1. Introduction

1.1 Defining public research organisations

Public research plays a vital role in Europe's innovation ecosystem, with governments historically assuming a strong role in shaping research and innovation. Within this landscape, it is important to distinguish between universities, research hospitals and public research organisations (PROs). While all contribute to public science and technological development, PROs form a diverse and institutionally distinct group where basic, applied or experimental research is the main and principal reason for their operations, in contrast with universities whose main mission is teaching or research hospitals where it is healthcare.

A broad working definition describes PROs as "non-university and non-enterprise organisations focused on research, which are public in nature or under significant government influence" (Cruz-Castro et al., 2020). This definition captures the wide range of PROs, from large national institutes to private non-for-profit centres with more specialised mandates.

1.2 Why this report?

This study presents the first comprehensive analysis of patenting by European research institutions across all 39 member states of the European Patent Organisation (EPO). Research institutions play a central role in Europe's knowledge and innovation systems, yet their collective patenting activity has not previously been examined systematically at this scale. The study maps patent filings at the EPO by public research organisations (PROs) and research hospitals using a classification system based on the European OrgReg registry. To provide a more complete view of the public research landscape, the analysis also covers universities, allowing for direct comparisons across these key categories of public sector research actors.

To better understand the role of PROs together with universities and research hospitals within their innovation ecosystems, the study uses the concept of academic patents to measure patenting trends by these institutions. In addition, it examines how these institutions engage with their environment through startup creation and collaboration between each other and with industry through joint ownership of patent applications.

The study pursues three specific objectives. Firstly, it provides an assessment of the contributions of European PROs to patenting activity at the EPO, through direct and indirect academic patenting. Secondly, it analyses the overall contribution of all types of European research institutions, comparing the individual contributions of PROs, universities and research hospitals by examining patent volumes, temporal evolution and the ratio of direct and indirect patent filings. Thirdly, it assesses their involvement in European research integration and the broader European innovation ecosystem through co-applicant activity with industry and across borders, as well as their links to startup activity.

This project is part of the broader mission of the EPO's Observatory on Patent and Technology to support evidence-based decision making on innovation. It builds on earlier Observatory work on universities (EPO, 2024) and expands the framework to include other public research actors. To support the development of this study, the EPO Observatory collaborated with experts from the national patent offices of 24 EPO member states who contributed insights, validation and context, reinforcing its relevance and applicability across Europe. For more information, visit epo.org/observatory and the topic page on public research and innovation.

1.3 Structure of the study

The report is structured into five main parts. The next section serves to contextualise the role of public research organisations in Europe, outlining their diversity, use of intellectual property, commercialisation practices and the role of academic patents as a measurement of innovation. Section 3 analyses the PRO patent landscape, covering growth patterns, characteristics, technological specialisation and the profiles of Europe's leading institutions. The report then broadens its scope to benchmark PROs, universities and research hospitals in Section 4, highlighting their comparative contributions and technology specialisation. Section 5 explores their impact on the European innovation ecosystem, focusing on collaboration networks and startup creation. The final section concludes with the main findings and implications. Annexes provide a methodological note on academic patents and a list of PROs across EPO member states based on their number of academic patents.

2. Public research organisations in Europe

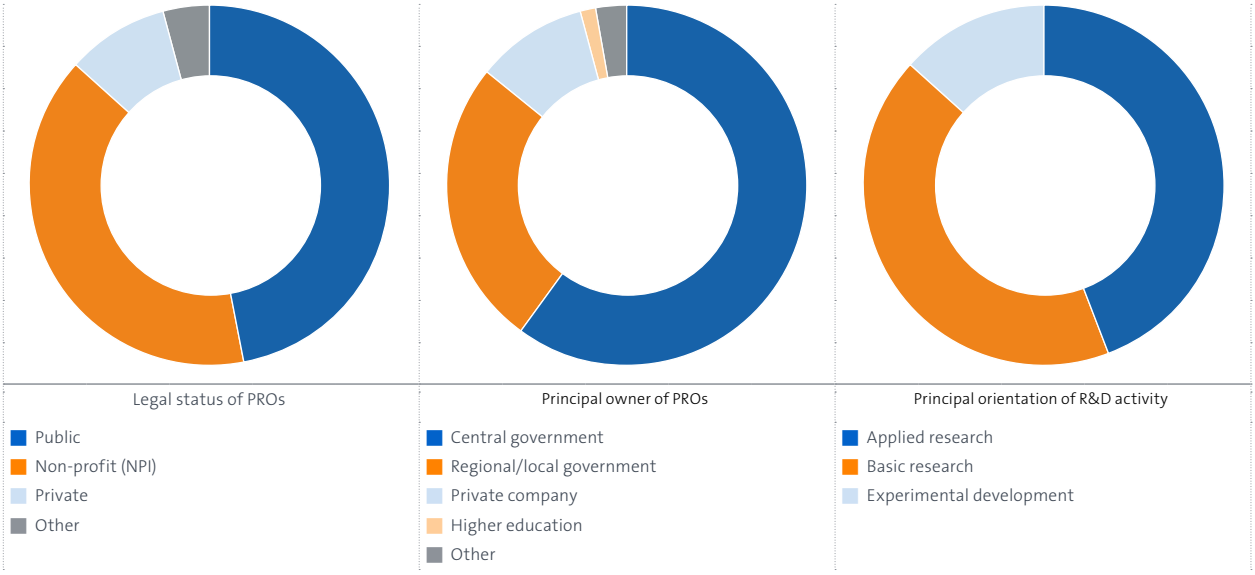
2.1 The diversity of European PROs

The prominent place of PROs in the European research ecosystem stems from historical and structural factors, including more centralised state involvement in research, fragmented university systems and strong traditions of national economic planning. In the post-war period, many European governments established public research institutes to compensate for perceived gaps in university-based research and to steer national innovation policies (OECD, 2011). As a result, the European landscape includes well-established organisations such as the French CNRS, the German Fraunhofer Society, Spain's CSIC, Italy's CNR and the Netherlands' TNO. These institutes have become central players in their national innovation systems and active participants in European research initiatives.

One recent effort to map and classify the diversity of PROs in Europe was proposed by Cruz-Castro et al. (2020), who analysed a sample of 197 organisations across eight countries. Their findings confirm that PROs cannot be understood as a uniform group. As shown in Figure 1, their sample varies significantly in terms of legal status, ownership structure and research orientation. Most PROs are either public or non-profit entities, with ownership often distributed between central governments and regional/local authorities. The majority are focused on applied research, though basic research and experimental development also play important roles in the portfolio of many institutions.

Figure 1

Composition of PROs in Europe



Source: adapted from data of Cruz-Castro et al., 2020

Over time, PROs in Europe have evolved from more centralised, state-owned institutions focused on national priorities to a more diverse landscape of organisations (OECD, 2011; EARTO, 2013). In Central and Eastern Europe, the post-1990s restructuring of Soviet-style science systems led to the fragmentation and downsizing of many institutes, which often became smaller and more specialised. Similar trends are visible in Western Europe, where new, more flexible PROs have emerged, such as the Joanneum Research in Austria and Tecnalia in Spain.

These are part of the so-called Research and Technology Organisations (RTOs): non-profit, industry-facing entities that operate with institutional autonomy, focus on applied or experimental research and maintain close ties with the private sector. While their legal status is not always fully public, they typically involve regional or national governments and pursue public missions; for the purposes of this study and following OECD definitions, they are considered PROs (EARTO, 2021).

At the same time, larger PROs such as CNRS in France, CSIC in Spain and CNR in Italy continue to play a prominent role. These institutions are directly managed or funded by national governments and historically have had a strong focus on basic research across a broad range of disciplines. They are also increasingly engaged in technology transfer and industrial collaboration, through Technology Transfer Offices (TTOs) and internal teams to support patenting, licensing, spin-off creation, and partnerships with private firms. This growing attention to application and innovation reflects a broader shift in the public research landscape, where PROs are aligning closely with economic and societal goals (OECD, 2011; EARTO, 2021).

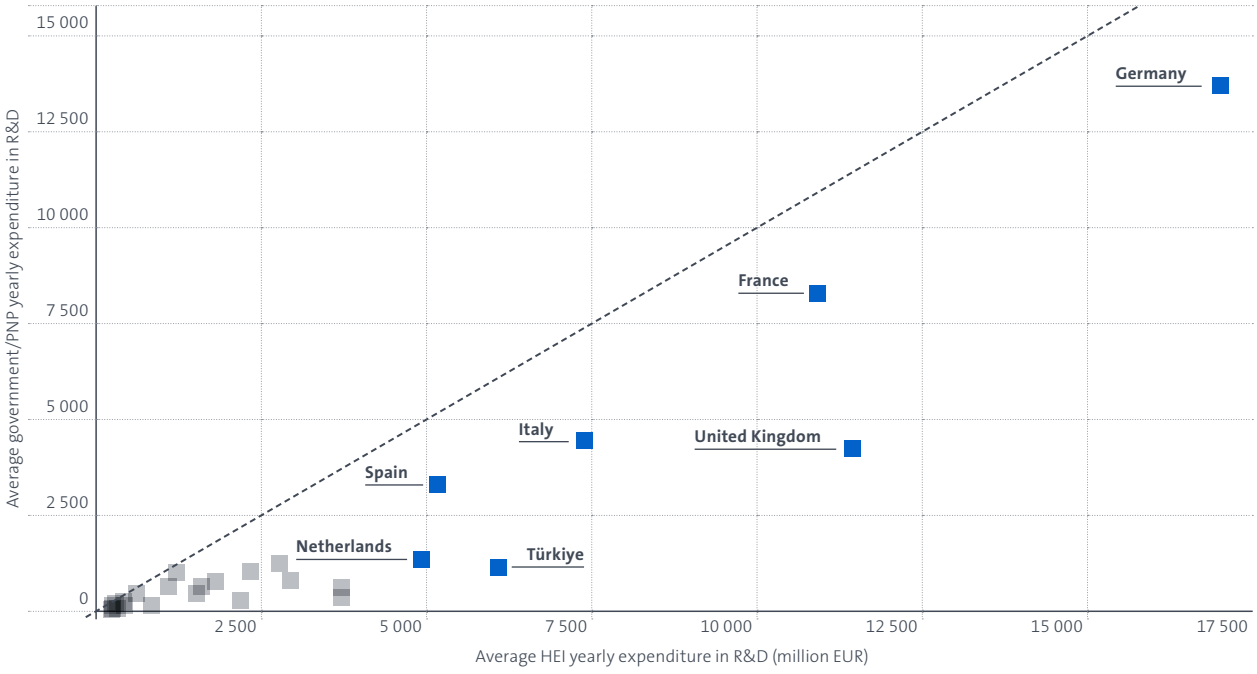
This diversity of models of public research is also reflected in R&D spending. The OECD (2025) classifies public R&D spending across three main sectors: higher education institutions (HEIs), private non-profit (PNP) organisations, and other government bodies. The PROs considered in this study, following the definition by Cruz-Castro et al. (2020), are typically included under the PNP and government categories.

Figure 2 presents the distribution of R&D expenditure by sector in European countries covered by the OECD database. In nearly all cases, HEIs account for a larger share of public R&D spending than PROs, as indicated by the fact that most countries fall below the dashed 50:50 line. However, national models vary significantly. Germany and France show a relatively balanced distribution between HEIs and PROs, while countries such as the UK, the Netherlands and Türkiye concentrate public R&D spending far more heavily in the higher education sector.

This pattern is particularly striking in the UK, where world-renowned universities like Oxford, Cambridge and University College London (UCL) dominate the national public research and innovation landscape, and PROs play a comparatively modest role. R&D spending in the UK is heavily concentrated in the higher education sector, reflecting longstanding policy choices that have favoured university-based research. This structure has evolved alongside shifts towards short-term project-based funding and changes, governance and budget decisions. Recent analysis by the Royal Society shows that in the last number of years, the UK invested around 0.10% of GDP in government R&D (GovERD), less than half the OECD average (0.24%) and well below Germany (0.42%) (Royal Society, 2020).

Figure 2

Average yearly expenditure in R&D by sector (2000-2020) in euros (in Purchasing Power Parity)



Source: adapted from data of OECD, 2025

The figures on R&D spending discussed above provide only a partial view of the role of PROs. Many of their contributions do not appear in these statistics, since they take place through intermediary structures and collaborative arrangements rather than direct research expenditure. Technology parks, for example, bring universities, research organisations and firms together in shared spaces that support high-tech companies and encourage knowledge transfer (Link & Scott, 2007; Cabral & Dahab, 2012). Studies show that such parks can strengthen regional innovation systems by linking universities, firms and public authorities (Vásquez-Urriago et al., 2016).

In France, the CNRS illustrates how a large PRO combines basic research with a strong partnership role, managing joint laboratories and licensing agreements to bring university research closer to industry. The French experience also shows how these connections can produce measurable outcomes. CNRS works closely with the national network of Sociétés d'Accélération du Transfert de Technologies (SATTs), which are part of its transfer structure and collaborate to move research results into the market. Most of the technology transfer activities from CNRS researchers are managed by the SATTs, with the remainder being undertaken by other TTOs (such as SATTe) and CNRS Innovation. Comparable efforts are visible across Europe, where organisations part of the EARTO members demonstrate varied approaches but share the objective of turning public research into tangible economic and societal benefits (EARTO, 2024).

2.2 Use of IP by PROs

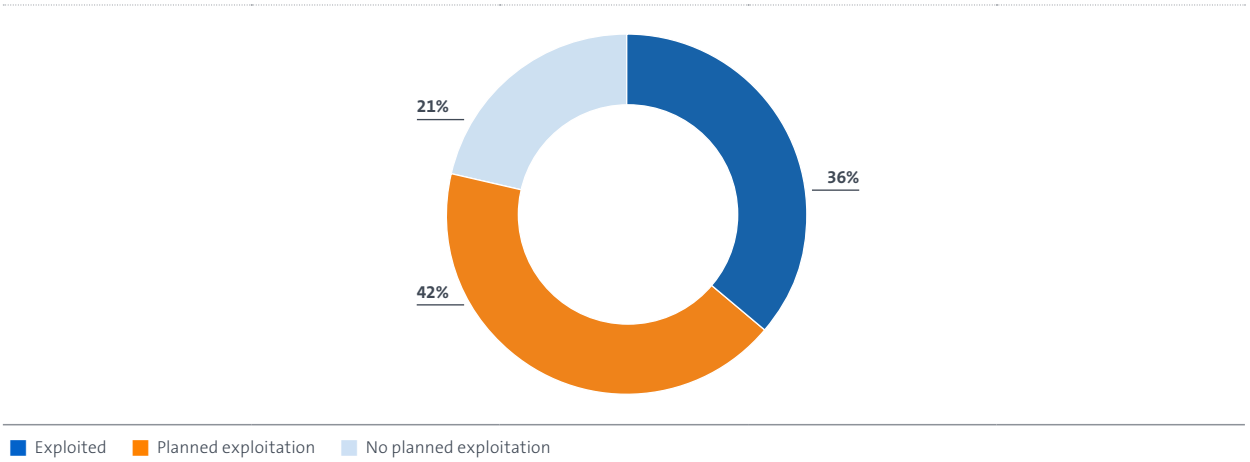
Intellectual property is key to commercialisation of academic and public research. By securing legal protection for inventions, patents and other IP rights provide a mechanism through which universities and PROs can transfer knowledge to the private sector while safeguarding public interests. IP enables them to engage in licensing, attract industrial partners and participate in collaborative innovation ecosystems. It also forms the basis for the creation of startups, allowing students and researchers to develop their own companies. In this context, well-managed IP portfolios are increasingly seen not only as a source of revenue but as a strategic tool for impact and creation of public value (OECD, 2013; European Commission, 2024).

Many research institutions have developed formalised strategies for knowledge valorisation and technology transfer, particularly since the early 2000s (OECD, 2013). These strategies include the establishment of Technology Transfer Offices, the adoption of institutional IP policies and the signing of licensing agreements with private partners. PROs such as Fraunhofer, CEA or VTT are known for their patenting activity and structured collaboration with industry, including the creation of startups and joint ventures. However, the overall uptake of IP protection remains uneven across the sector.

Data from a 2020 survey of the EPO to European universities and PROs show that 36% of their patent applications at the EPO were already exploited, while another 42% were at the planning stage (Figure 3). However, no plans existed for around one-fifth of them. A number of obstacles were reported that prevent successful exploitation; many technologies were still in development (63%) or undergoing prospecting (55%), which is typical for research-based inventions. Additional important challenges include the failure to find a partner (38%) or a lack of resources (25%). These figures reflect both the growing ambition of research institutions to bring inventions to market by protecting them with patents and the structural hurdles that continue to limit their commercial impact (EPO, 2020).

Figure 3

Status of patent commercialisation of European universities and PROs



Source: EPO, 2020

Available evidence suggests that compared to universities, PROs are more likely to file patents in their own name rather than through individual researchers (OECD, 2013). This occurs because PROs are typically more centralised than universities, owning all IP generated by employees. In universities, especially those with more academic autonomy or less centralised TTOs, some IP may be owned or assigned differently (EPO, 2024). PROs also tend to focus on collaborative or contract-based research with industrial partners, often resulting in co-owned patents or shared licensing frameworks. The diversity of PRO missions, governance models and proximity to application explains the variety of IP practices observed across Europe (OECD, 2013; European Commission, 2022). At the same time, differences in national legal frameworks, incentive structures and institutional capacities continue to shape how universities and PROs approach the generation and commercialisation of intellectual property.

2.3 Challenges and recent developments of commercialisation of public research

PROs across Europe have made substantial progress in transforming research outcomes into innovation. Their commercialisation models have evolved well beyond traditional licensing to include spin-off creation, collaborative R&D, public-private partnerships, student entrepreneurship, IP-backed financing and even crowdfunding (OECD, 2013; European Commission, 2023a). This growing diversity in technology transfer mechanisms is supported by both national policy frameworks and European-level initiatives, most notably Horizon Europe, which not only fund research but also provide instruments specifically designed to boost commercial outcomes (European Commission, 2025a).

These advances are reinforced by the broader goals of the European Research Area (ERA), which aims to harmonise research agendas, encourage cross-border collaboration, and better align public research with industrial and societal challenges. ERA's renewed agenda places greater emphasis on improving the conditions for knowledge valorisation and the circulation of talent, ideas and technologies across national borders (European Commission, 2025b).

Several European PROs have become international reference points for scientific excellence and innovation capacity. In Germany, Fraunhofer is renowned for its strong track record in applied research and IP-driven collaboration with industry, built over seven decades of technology transfer activities (Fraunhofer-Gesellschaft, 2024). The Max Planck Society leads in frontier and basic science and actively supports the commercialisation of fundamental research through structured IP management and technology transfer measures (Max Planck Innovation, 2025). In France, CNRS stands as a major global player in innovation, participating in 318 Horizon Europe projects and coordinating 135 in 2024 alone, making it the top beneficiary and co-ordinator in the EU research funding landscape (Raffaele, 2025; Euraxess, 2025).

CNR in Italy has participated in nearly 1 900 international and EU-funded projects, maintaining an active presence in the national ecosystems of basic research and innovation (CNR, 2025; SuperRED, 2024). In Spain, CSIC ranks first in patent filings among Spanish applicants, while Tecnalia, a leading applied research organisation in the Basque Country, holds a significant patent portfolio and is recognised as a successful case study supporting regional innovation ecosystems (EPO, 2024; UNGRIA, 2025; Tecnalia, 2020). While historically oriented towards fundamental research, many of these institutes now increasingly engage in patenting and external partnerships.

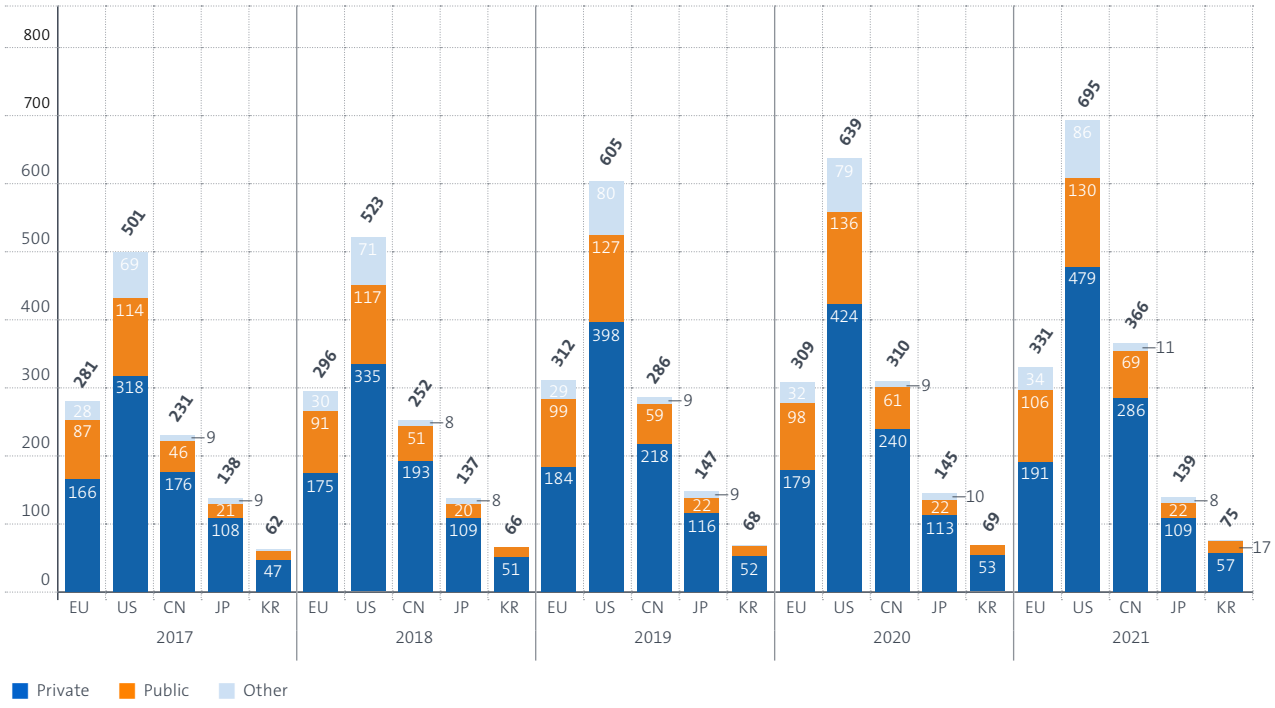
While these examples highlight the growing capacity of European PROs to support commercialisation, persistent challenges remain. A major one is the translational gap: the difficulty in moving early-stage scientific results to a level of maturity attractive to industry and investors. Many inventions require proof-of-concept, prototyping or additional development before they can be licensed or integrated into commercial applications (OECD, 2013; Morris et al., 2013; Nature, 2021). These constraints are especially visible in institutions with fewer resources, where access to seed funding, TTO personnel and innovation infrastructure is limited (OECD, 2019; Guerrero & Urbano, 2018).

Industry engagement also remains uneven across European countries. In economies with mature innovation ecosystems, PROs often maintain long-standing industrial collaborations. Elsewhere, finding industrial partners or building sustained relationships can be difficult. Internally, administrative complexity, unclear incentives or limited support structures can reduce the extent to which researchers engage in commercialisation efforts in countries with less tradition of industry collaboration.

These differences are reflected in comparative data on R&D investment. Figure 4, drawn from a recent European Commission analysis, shows that in the EU-27, public R&D investment represents a higher share of total R&D funding compared to China, the US, Japan and Korea. Yet despite this stronger public orientation, the EU's absolute investment in public R&D remains below that of its global competitors. The chart also highlights that China and the US have surpassed the EU in mobilising private sector R&D investment, pointing to a greater ability to convert public research into industrial innovation (European Commission, 2025).

Figure 4

Research expenditure: Public/private in EU countries, US, CN, KR, JP

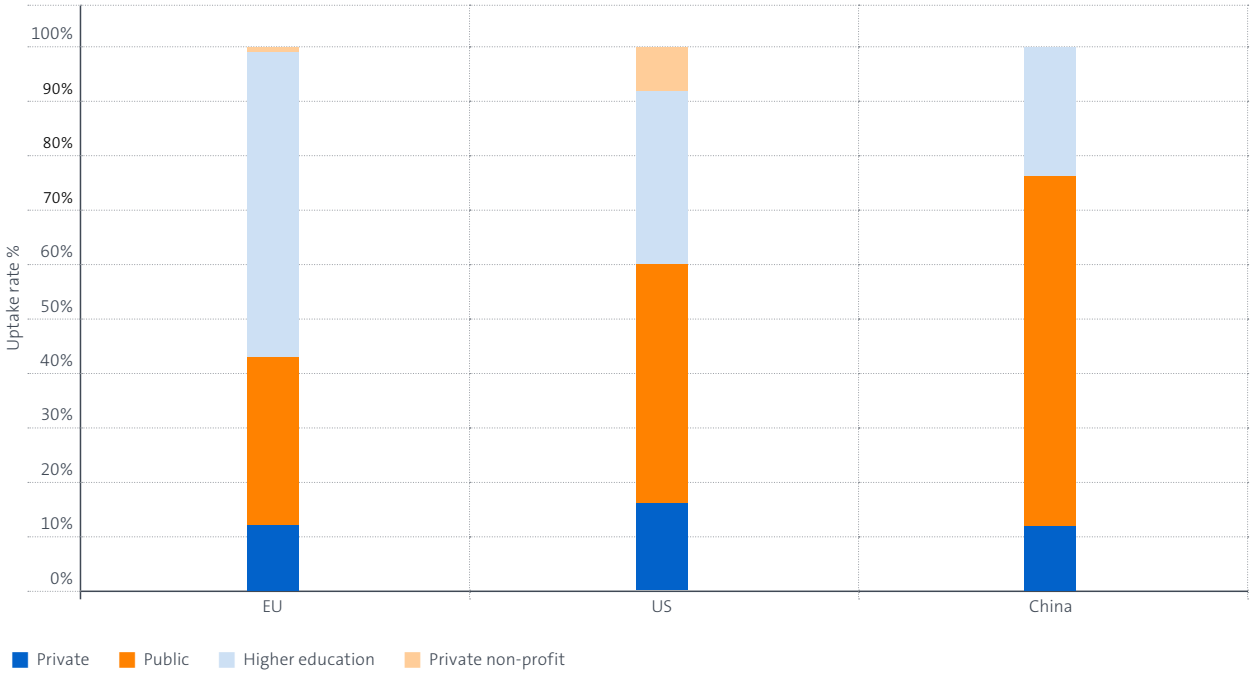


Source: European Commission, 2025e

A related issue concerns the sector of performance of public R&D, as shown in Figure 5. The EU performs a significant share of its public R&D through the higher education sector, around 31% in 2021, compared to 16% in the US and 12% in China. While this reflects the strength of Europe's universities, it also suggests a more fragmented landscape with multiple institutional approaches to research and commercialisation. By contrast, China and the US concentrate a greater portion of public R&D in dedicated public institutions or large-scale government research centres, allowing for more centralised coordination and potentially greater alignment with industrial strategies (European Commission, 2025c).

Figure 5

Sector of performance of public R&D funding in EU, US and CN



Source: European Commission, 2025c

While the data in Figures 4 and 5 refer specifically to the 27 member states of the EU, they show broader patterns that are relevant for Europe as a whole. They point to key structural issues, such as the need for more coherent strategies with the industry, deeper collaboration across sectors and a lack of focus in public research that is then able to scale up in the private market.

These differences are also driven by the fragmentation between the European and the US or Chinese public research ecosystems. For the most part, European public research organisations operate as country-focused entities; each country has its own system and strategies governing PROs and other research-performing organisations such as universities or research hospitals. The Future of European Competitiveness by Mario Draghi argues that closing Europe's innovation gap requires deeper integration and a more co-ordinated approach to research and innovation. This is echoed by the report prepared by Enrico Letta on the Single Market, which proposes a "fifth freedom", the free movement of knowledge, research, innovation and education.

In response, some action is already underway. At the public policy level, the European Research Area (ERA) promotes cross-border research collaboration by funding projects across countries and supporting greater policy coordination among member states. Recent developments, such as the launch of the European Unitary Patent, are seen in the Draghi report (2024) as important steps towards reducing market fragmentation, lowering costs and improving legal clarity for innovators across Europe. Private initiatives are also contributing, for example, the Dioscuri Initiative by the Max Planck Society

is fostering scientific and innovation excellence in Central and Eastern Europe (Max Planck Innovation, 2024). Nonetheless, PROs and national research systems in Europe still tend to operate within national frameworks rather than in a fully integrated European market.

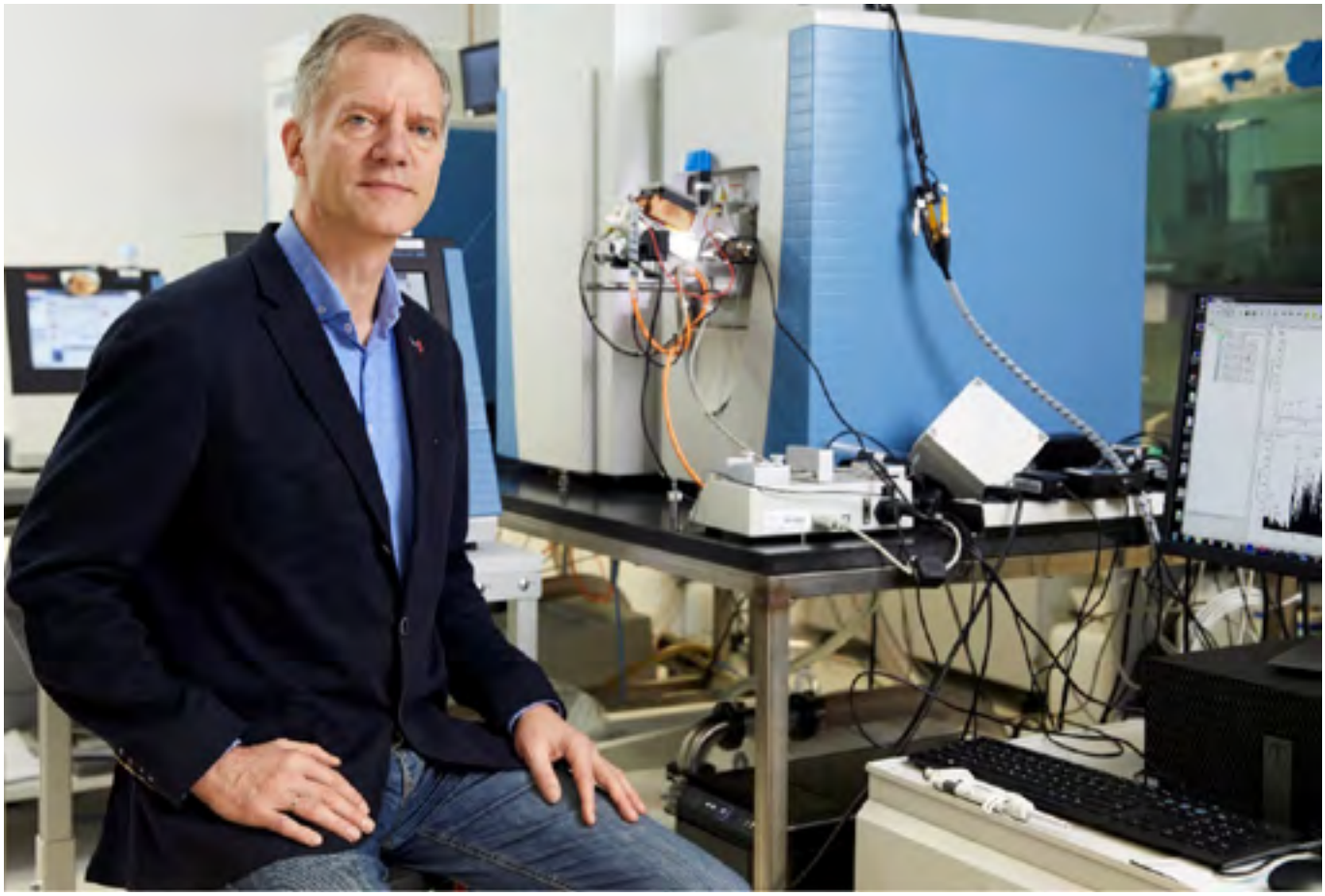
2.4 Academic patents as a measurement of innovation

Assessing the innovation output of public research organisations, universities and research hospitals through patent data presents both opportunities and challenges. Differences in institutional ownership models, missions and incentives across Europe make it difficult to rely solely on organisational patent filings as a metric. Focusing on raw counts may risk overstating the role of institutions with high-volume strategies while overlooking more targeted, collaborative or mission-driven innovation efforts.

To address these limitations, a more refined approach is needed, one that focuses not only on who owns the patent but on who invents it. Following a similar method to that applied in the EPO Observatory's 2024 report on universities (The Role of European Universities in Patenting and Innovation), this study adopts the concept of academic patents, extended here to include PRO and hospital researchers as inventors. This approach allows us to trace the innovation footprint of European PROs more accurately, regardless of whether the patent is filed by the PRO itself, by a co-owning partner or by an external entity involved in joint research, and compare them to the contributions of universities and research hospitals.

Academic patents are defined as those whose inventors work or study as researchers in universities, PROs or research hospitals, including patents directly filed by these institutions, but also ones filed by other entities. This methodology has been widely used in innovation studies (Meyer, 2003; Lissoni, 2008; Perkmann et al., 2013) and is particularly relevant for PROs, whose institutional structures and patenting behaviours are often heterogeneous and embedded in collaborative frameworks. By applying this method, the present study aims to provide a more representative picture of the contributions of European PROs, universities and research hospitals to technological development and knowledge transfer.

Another reason for adopting this approach is the structural diversity of Europe's research landscape. Much like the case of universities, focusing only on the largest or most prolific patent applicants risks overlooking a broad segment of organisations, many of which are smaller, more specialised and region focused. In the last study on universities, it was shown that the top 20 institutions accounted for only 30% of EPO filings (EPO, 2024). A similar pattern may hold among PROs, where smaller or sectoral institutes can play a key role in regional innovation systems or specific industrial ecosystems. Therefore, this study moves beyond simple rankings to explore the distributed and diverse nature of innovation and patenting activity across different types of research institutions in Europe.



Case study: PreOmics

Headquarters	Martinsried, Germany
Founded	2016
No. of employees	61
Products	Tools for mass spectrometry-based protein analysis
Partner institution	Max Planck Institute of Biochemistry
European Inventor Award finalist	https://www.epo.org/en/news-events/european-inventor-award/meet-the-finalists/matthias-mann

PreOmics is a German startup that develops advanced tools for mass spectrometry-based proteomics, supporting researchers worldwide in their protein analysis. The company's origins can be traced to a research group at the Max Planck Institute of Biochemistry, where Matthias Mann and students Nils A. Kulak and Garwin Pichler worked to simplify and standardise complex proteomics workflows. Building on this foundation, and with support from the technology-transfer arm of the Max Planck Society, Kulak and Pichler licensed Mann's patents and founded PreOmics to commercialise their research.

Predictive power of proteins

Proteins are the functional machinery of life, carrying out cellular processes and reflecting the body's state of health. While DNA provides a blueprint, proteins capture dynamic changes that can signal the earliest stages of disease. This makes proteomics – the large-scale study of proteins – a powerful tool for uncovering hidden health threats. Yet for decades, scientists struggled to measure proteins in sufficient depth and scale to make these insights clinically useful.

Matthias Mann helped overcome these barriers by pioneering new methods in mass spectrometry. His development of nano-electrospray in the 1990s enabled researchers to identify and sequence thousands of proteins in parallel, transforming proteomics from a conceptual promise into a practical discipline. Building on this, he introduced SILAC, a stable isotope labelling technique that marks proteins in a machine-readable way, allowing diseased and healthy cells to be compared with unprecedented speed and accuracy.

Together, these advances have provided clinicians and researchers with tools to map entire proteomes in hours rather than years. By identifying protein "signatures" or biomarkers, they open possibilities for earlier diagnosis of conditions such as cancer, fatty liver disease or neurodegenerative disorders and for tailoring more precise treatments.

Spinning out: The founding of PreOmics

Motivated to commercialise their work, members of Matthias Mann's research group at the Max Planck Institute of Biochemistry launched a spin-out in 2016 called PreOmics. The founders, Kulak and Pichler, had been working since 2010 on ways to simplify liquid chromatography – mass spectrometry (LC-MS) workflows. Their breakthrough in 2014 was an optimised, easier method of sample preparation that proved robust when tested in external laboratories.

With support from proteomics experts, engineers and industry designers, they transformed this method into a practical kit and, by licensing Mann's patents, secured the rights to commercialise their technology. The resulting product enabled non-specialists to prepare samples for proteomic testing in a standardised and reproducible way.

Funding the path from spin-out to scale

Like many early-stage deep tech ventures, PreOmics combined public and private funding to move from a research idea to a commercial enterprise. In its earliest years, the company benefited from grants and seed investment that allowed the founders to refine their kits, establish operations at the Innovation and Start-Up Center for Biotechnology (IZB) near Munich and validate their workflows with external laboratories. Institutional support included funding from the European Union's Horizon 2020 programme for the iSTantibody project, as well as advice and facilitation from Max Planck Innovation, which had brokered the initial licence of Mann's patents.

Growth capital followed once the company had a demonstrable product and early traction. A €3.3 million Series A financing round in 2019, led by Think. Health Ventures with participation from High-Tech Gründerfonds (HTGF) and several business angels, supported internationalisation and expansion of the product line. The most significant step came in 2022, when Bruker Corporation provided €13.5 million in Series B financing and acquired a majority stake in the company through a parallel secondary transaction. The investment not only secured long-term backing but also created a strategic partnership: Bruker integrated PreOmics' sample-preparation technologies into its mass-spectrometry systems, advancing the push towards automated, end-to-end proteomics workflows.

Adding value to customers

PreOmics generates revenue primarily through the sale of proprietary consumables and automation-ready systems that simplify proteomic sample preparation. Its flagship iST kit integrates all steps of peptide and protein

preparation in a single workflow, complemented by products such as the iST NHS kit for chemical labelling, PHOENIX for peptide clean-up and the PreON system for fully automated preparation. These tools reduce time and variability while improving reproducibility, making large-scale or clinical proteomics studies more feasible.

The company serves a broad client base, including leading academic institutions, pharmaceutical companies and biotechnology firms. In addition to product sales, PreOmics offers consultation services to help laboratories adapt workflows to specific research needs. By combining standardised consumables with automation-compatible systems, the company has carved out a growing niche in the proteomics market, lowering technical barriers and expanding adoption beyond specialist labs.

Driving innovation

Max Planck Innovation (MI) acts as the link between science and industry, promoting the translation of research into marketable products and services. As the technology transfer organisation for the Max Planck Society, MI evaluates an average of about 140 inventions each year, with around 80 progressing to a patent application. Since 1979, it has supported more than 5 100 inventions and concluded over 3 100 commercialisation agreements. PreOmics is just one of more than 200 spin-out companies that have emerged from the Society since the early 1990s. With the vast majority of these actively supported by MI, the spin-outs have created approximately 9 500 jobs. Cumulative revenues from licences and equity disposals total approximately €570 million.

3. The PRO patent landscape

Understanding PRO patenting activities is essential for assessing how Europe's public research infrastructure translates scientific knowledge into protected innovations that can drive industrial competitiveness and economic growth. This chapter provides a comprehensive analysis of European PRO patent activity, examining temporal growth patterns in patent filings and scale since 2001 until 2020, the geographical distribution and technological characteristics of PRO patent applications, and the institutional profiles of Europe's largest and most patent-active PROs. By mapping these dimensions, the analysis reveals how PROs contribute to Europe's innovation landscape and their importance for European and national innovation ecosystems.

Box 1: Definition of PROs and classification

Public research organisations (PROs) are defined in this study as "non-university and non-enterprise organisations focused on research, which are public in nature or under significant government influence", following Cruz-Castro et al. (2020). PROs are therefore distinct from universities and from research hospitals, which typically have primary missions other than research.

Research hospitals are defined as hospitals which, alongside their clinical activity, also perform a substantial amount of medical research. Many research hospitals are closely associated with or part of universities and are therefore engaged to some extent in teaching. The delimitation criteria applied is that research hospitals must produce a sizeable number of scientific publications that can be retrieved from publication databases. The identification of research hospitals in this study, therefore largely follows the definition and data provided by the OrgReg registry from RISIS (Research Infrastructure for Science and Innovation Policy Studies). Healthcare organisations with a large R&D component are classified as research hospitals, while research centres in medicine without educational and healthcare components fall under the broader PRO category.

PROs may be public organisations but can also include private non-profit institutions with a public research mission. To compile a comprehensive list of such organisations across the 39 member states of the European Patent Organisation, the OrgReg registry was used to identify names, unique identifiers and other relevant data. Our definition of public research organisations (PROs) draws on OrgReg classifications, primarily including entities listed on OrgReg as "PROs", "Public administration organisations" and/or "Private non-profit organisations (PNPs) " following the definition of Cruz-Castro et al. (2020). Umbrella organisations are included when they maintain centralised decision-making authority, and affiliated organisations when they are directly responsible for such decisions. Technology Transfer Offices are linked to their related institutions, i.e. the Technology Transfer Office of an independent PRO is linked to "Independent PRO", while the Technology Transfer Office of a private non-profit PRO is linked to "PNP".

Table 1

Definition of public research organisation

Type of PROs	Criteria
Independent PROs	**PROs that:** • have R&D as the main mission of the entity • are part of the public sector (public mission, no exclusive market orientation) • have functional independence from the state in the conduct of R&D
PA (public administration)	**PROs that:** • are part of the public administration with no substantive independence • have a policy or service mission • have R&D as a collateral mission or sizeable volume of R&D
PNP (private non-profit)	**PROs that:** • have R&D as the main mission • have no government control • have no exclusive market orientation

Source: Lepori, (2022). OrgReg Methodological manual. Zenodo. https://doi.org/10.5281/zenodo.6396703

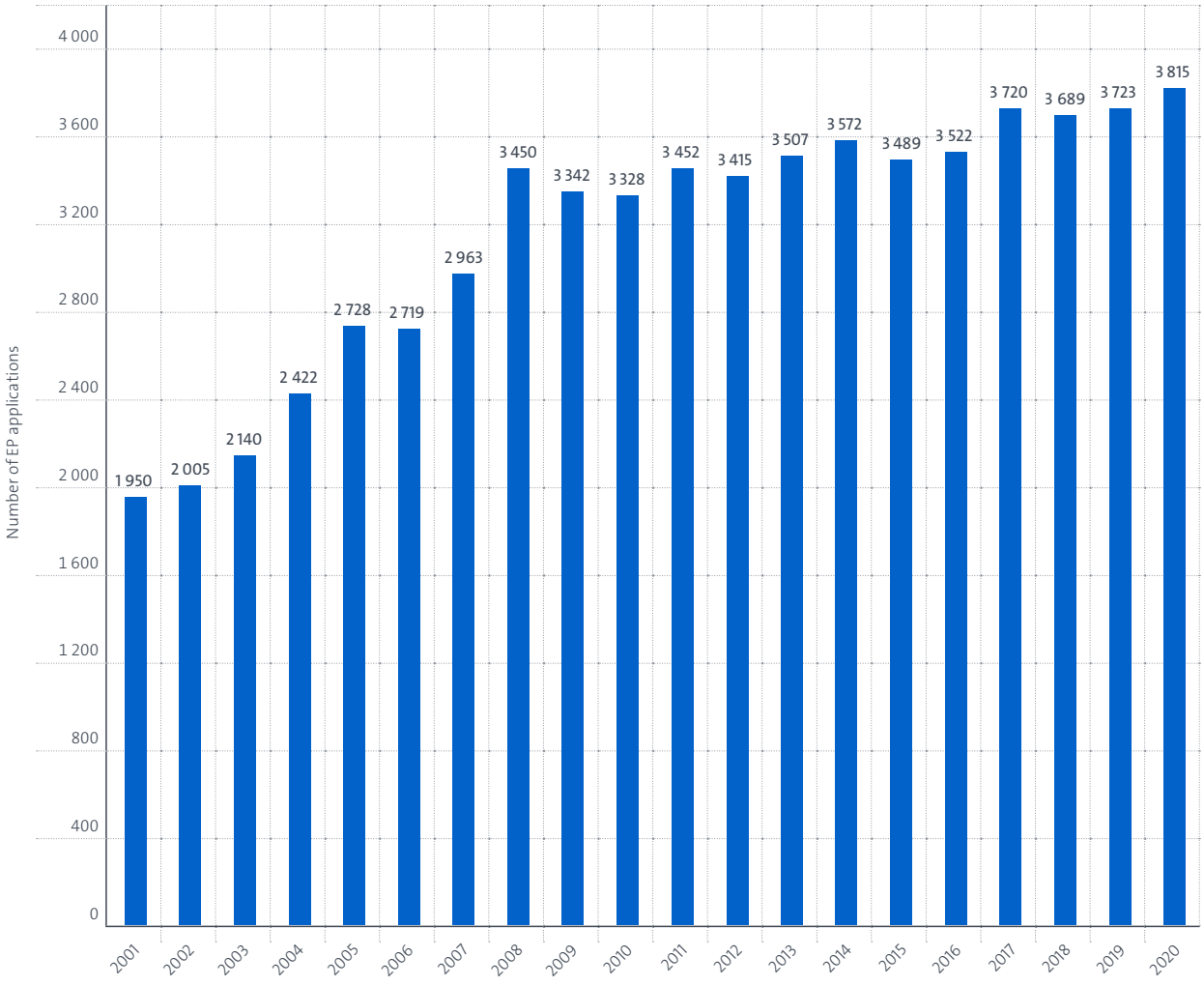
This resulting list of PROs from OrgReg was further complemented to include members of the EARTO association and the TTO Circle, which represent some of the largest and most prominent PROs in Europe. To support the correct disambiguation and classification of countries, the EPO collaborated with the national patent offices of its member states, with 24 offices joining this project and supporting by reviewing the lists of PROs included in this study.

3.1 Scale and growth patterns of PRO academic patents

Between 2001 and 2020, almost 63 000 European patent applications were filed at the EPO with involvement of European PROs, either as applicants or through researcher inventors affiliated with PROs (see Box 2 for the definition of PRO-related academic patents). The number of such EP applications grew steadily from 1 950 in 2001 to 3 815 in 2020, representing a compound annual growth rate (CAGR) of 3.6% over the 20-year period (Figure 6).

Figure 6

Number of European patent applications with PRO involvement, 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

Box 2: Definition and economic role of European academic patents

In this report, the concept of academic patents encompasses European patent applications originating in a European research institution, either a European PRO, a European university or a European research hospital. The set of academic patents includes all European patent applications filed directly by a European research institution (direct academic patent) or that have inventors who are researchers affiliated with a research institution (indirect academic patent).

PRO-related academic patents are the sum of two mutually exclusive subcategories:

— **PRO-related direct academic patents:** All European patent applications with at least one applicant recognised as a European PRO (according to the definition in Box 1). These applications may also be co-filed with other entities, such as companies, individuals, non-European research institutions as well as European universities or research hospitals, but must include a European PRO as applicant or co-applicant.

— **PRO-related indirect academic patents:** All European patent applications with at least one inventor matched to a European PRO (see Annex 1 for the methodology note), but which have not been filed or co-filed by any of the PROs in the reference population. These applications can have companies, individuals, non-European research institutions, but also European universities or research hospitals as applicants.

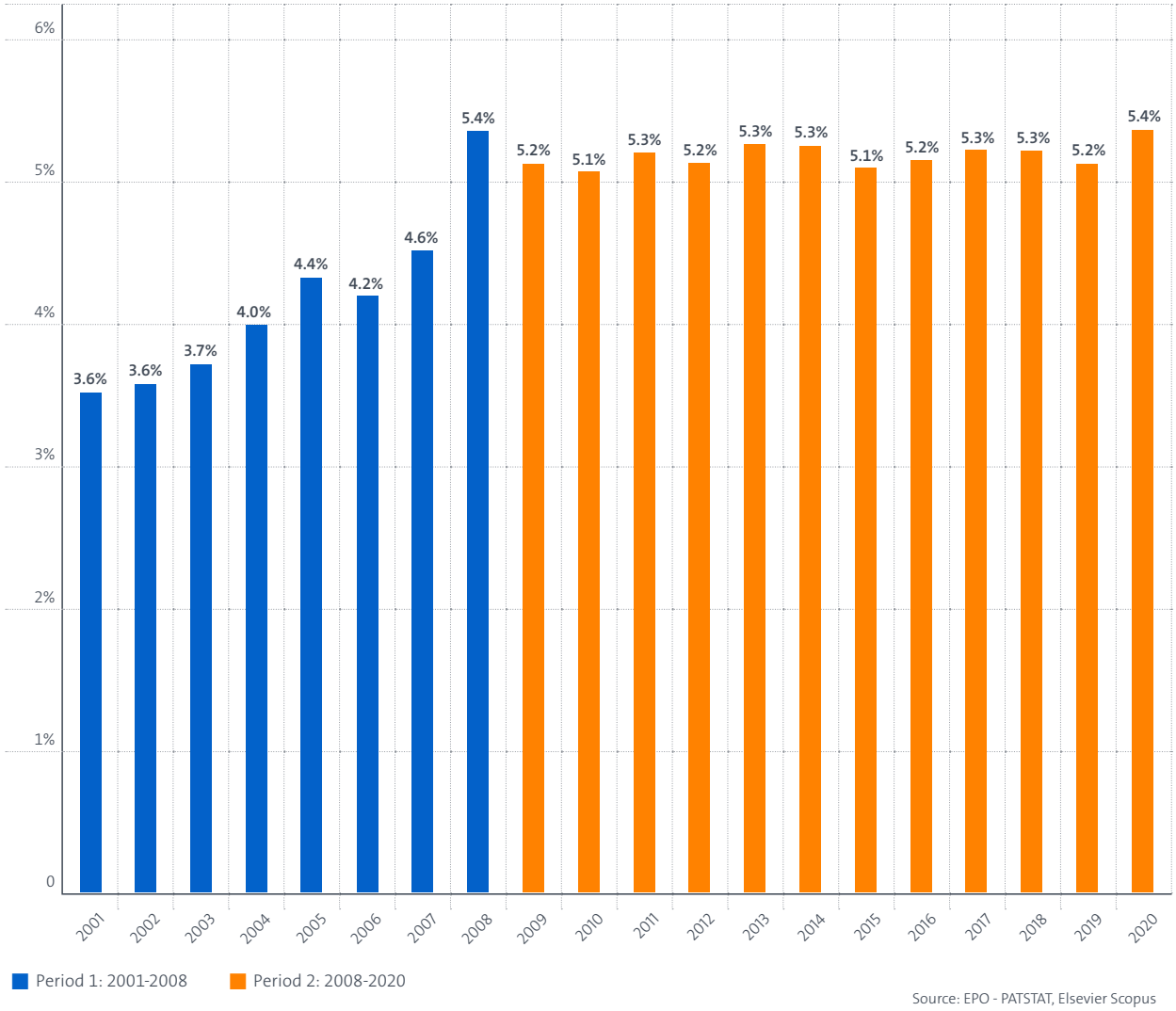
Whenever necessary, the same methodology is applied to the individual populations of patent applications related to European universities and research hospitals.

Direct and indirect academic patents can reflect different channels for research institutions to transfer knowledge and generate impact. Patents directly filed by PROs are owned and controlled by the organisation, and may be commercialised through licensing, assignment or contribution to spin-offs and startups. Indirect applications commonly arise from collaborations between PROs and external partners – especially in industry – where the partner organisation is contractually entitled to the patent resulting from joint research. They may also result from less formal arrangements, such as when researchers affiliated with a PRO collaborate or start their own ventures independently (cf. Lissoni, 2010).

As a share of total European patent applications filed by European applicants, PRO-related academic patents accounted for 4.9% over the full period 2001-2020. The data reveal two distinct phases in PRO patenting development. During the 2000s, patenting activity with PRO involvement grew faster than overall European patenting, with the PRO share increasing from 3.6% in 2001 to 5.4% in 2008. Subsequently, following the global financial crisis, PRO contributions stabilised above 5%, indicating growth rates similar to those of European patent applicants overall. The share reached its peak value of 5.4% again in 2020 (Figure 7).

Figure 7

Share of PRO-related applications in European patent filings by European applicants, 2001-2020

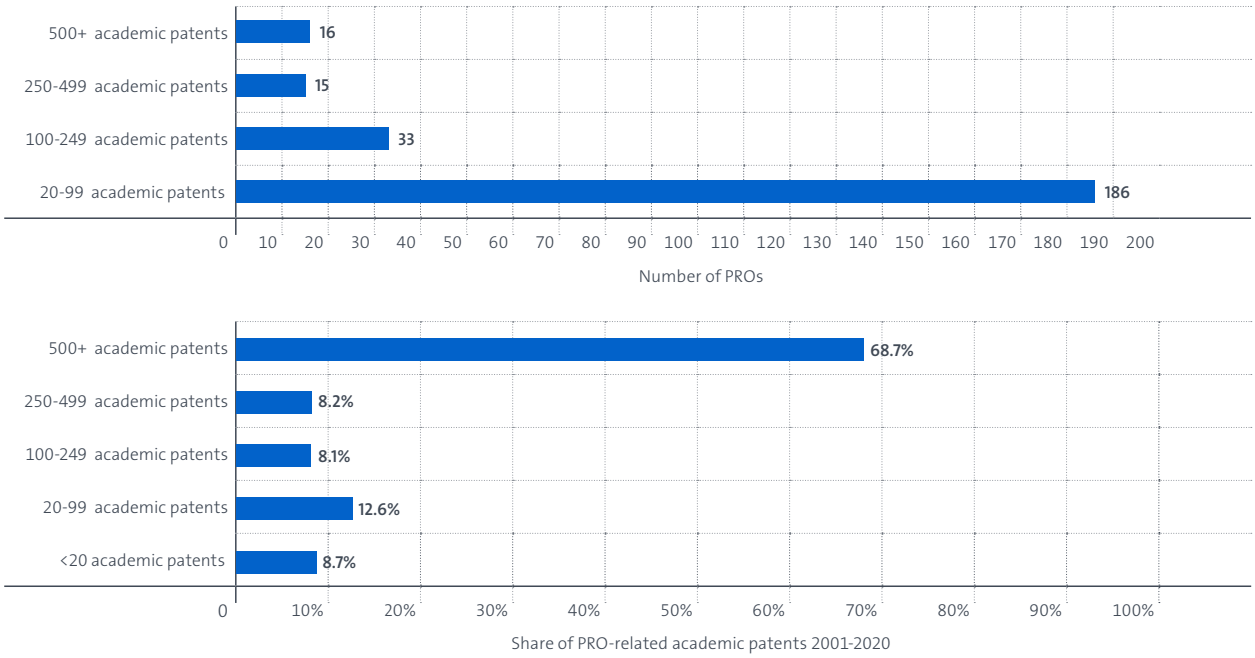


Source: EPO - PATSTAT, Elsevier Scopus

Figure 8 shows the high concentration of Europe's PRO academic patents on a small group of research institutions. In total, 250 European PROs contributed to at least 20 European patent applications between 2001 and 2020. The vast majority (186 PROs) contributed fewer than 100 applications in that time period, while only 16 institutions contributed to 500 or more European patent applications. The concentration of patenting activity is particularly striking and significantly higher compared to European universities: the top 16 institutions with 500+ patents account for 68.7%, or over two-thirds, of total PRO-related academic patent. In the case of European universities, top institutions with over 500 EP applications represented less than one-third of all university-related academic patents in Europe (EPO, 2024).

Figure 8

Distribution of European PROs by academic patent volume and share of patent applications by PRO size categories, 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

The distribution suggests a dual-tier European PRO ecosystem: a small number of large research organisations with substantial EPO patent portfolios alongside a much larger population of smaller institutions that may be more technologically specialised or focused primarily on scientific publishing. Note that the analysis in this report is based exclusively on European patent applications and does not capture purely national patent filings.

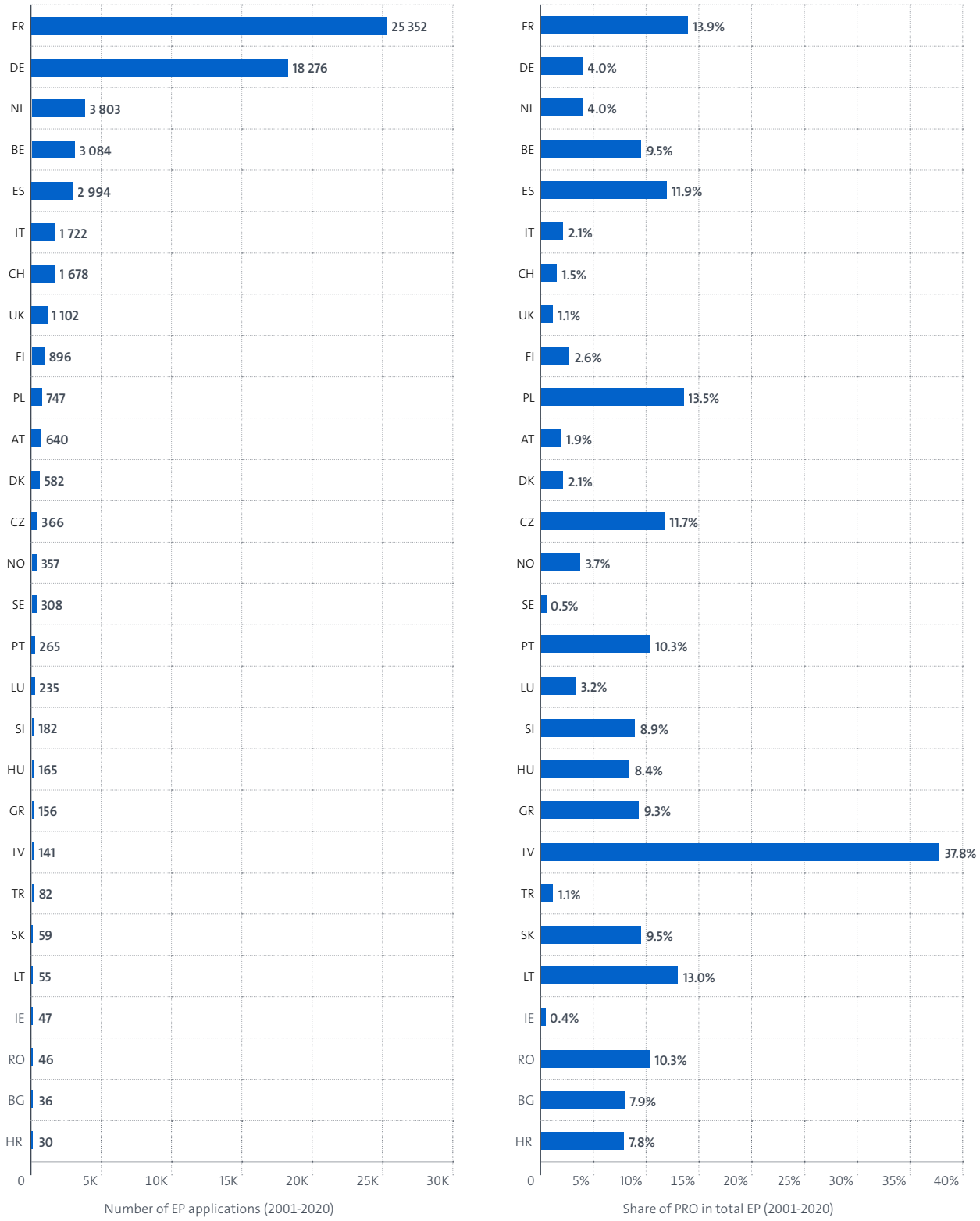
Figure 9 shows the distribution of PRO-related academic patents across EPO member states. It reveals significant variation in both absolute contributions and relative importance compared to all EP applications filed by entities from the same country. French PROs dominate with over 25 000 EP applications, or 40.3% of all European PRO-related academic patents between 2001 and 2020, followed by German institutions with over 18 000. At a considerable distance, Dutch PROs filed 3 803 applications, while Belgian and Spanish institutions each contributed around 3 000. Italian, Swiss, and UK PROs each exceeded 1 000 EP applications during this period.[1]

Beyond absolute numbers, the relative importance of a country's PRO contributions to total EP applications from the same country varies significantly. Latvia exhibits the highest PRO share, with academic institutions accounting for over 37% of total EP applications filed by Latvian applicants. Seven additional countries show PRO contributions exceeding 10% of their national EP applications: France (13.9%), Spain (11.9%), Poland (13.5%), Czech Republic (11.7%), Portugal (10.3%), (Lithuania (13.0%), and Romania (10.3%). This pattern also suggests that PRO contributions are generally higher in Eastern European countries than in Western European counterparts, potentially reflecting differences in national innovation systems and the institutional organisation of research and development activities. Notably, major contributing Western European countries like Germany (4.0%), the Netherlands (4.0%), the UK (1.1%), Italy (2.1%) and Switzerland (1.5%) demonstrate substantial absolute PRO output but relatively modest shares of the total patenting output from these countries.

1 The data also includes European research institutions, such as European Molecular Biology Laboratory, European Space Agency and European Organisation for Nuclear Research. Their combined contribution to EP applications in the period 2001-2020 amounted to around 400 academic patents.

Figure 9

Number of PRO-related academic patents with at least 50 EP applications by country of origin (left) and share in country's total EP applications (right), 2001-2020



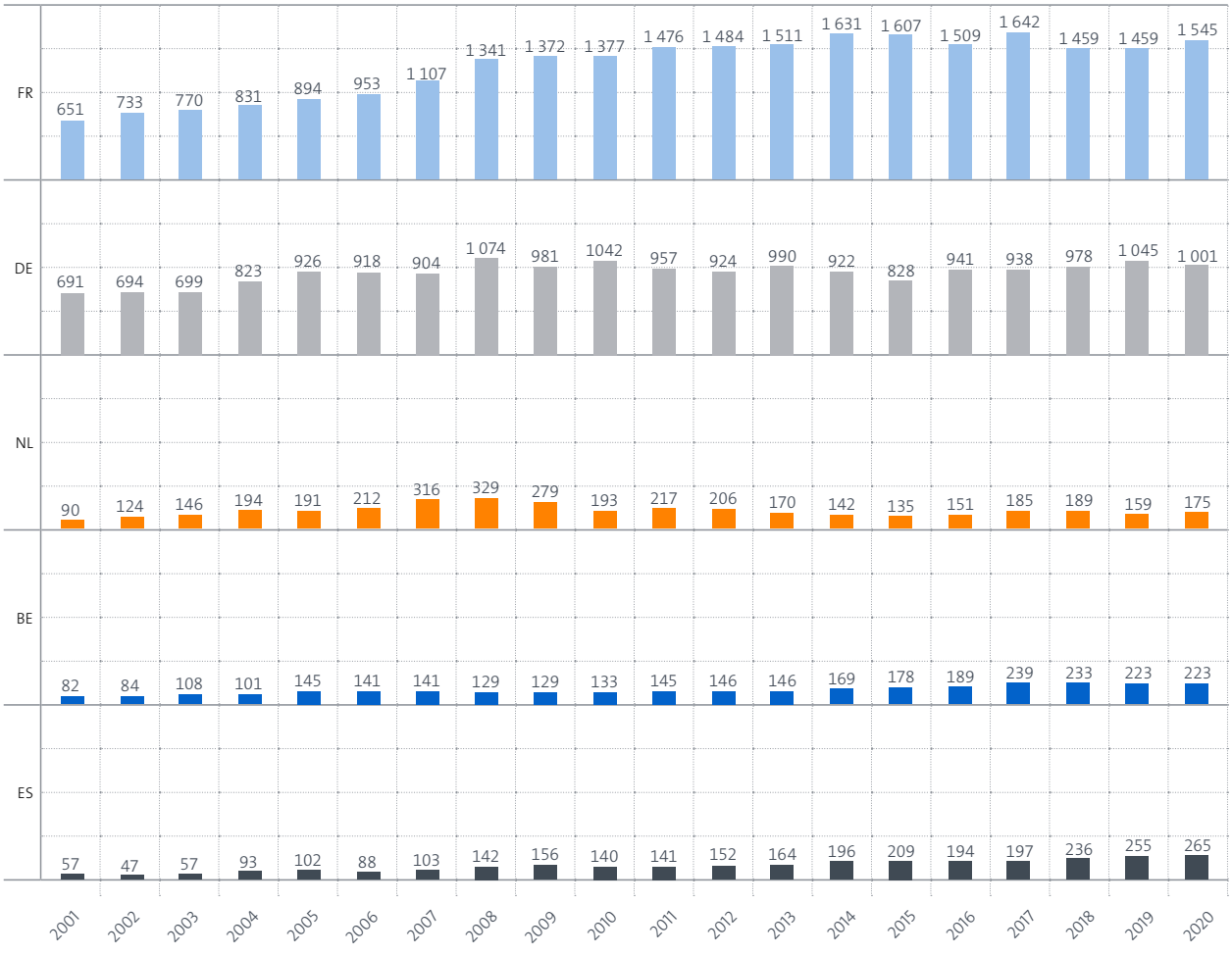
Source: EPO - PATSTAT, Elsevier Scopus

The following Figures 10 and 11 present the trends in PRO-related academic patents from the top five European countries that collectively contributed almost 85% of all European PRO-related academic patents between 2001 and 2020. French PRO-related EP applications increased from 651 in 2001 to over 1 600 by 2014, peaking at 1 642 in 2017 before declining to 1 545 in 2020. Despite this recent decline in absolute numbers, the academic share reached its peak of 17% in 2020 due to a parallel decline in total French patent applications from their 2014 high.

PRO-related EP applications in Germany increased from 691 in 2001 to over 1 000 in 2020, with a peak of 1 045 applications in 2019. The academic share grew modestly from 3.2% to 4.6% over the period, as Germany's total patent applications remained essentially flat. This represents the most stable but proportionally smallest academic patent share among the five countries. The Netherlands doubled its PRO-related applications from 90 to 175 between 2001 and 2020, but experienced significant volatility with an early peak of 329 applications in 2008 and a decline thereafter. The academic share similarly peaked at 6.9% in 2008 before declining to 3.6% by 2020. Belgium demonstrated strong growth, with PRO-related applications increasing from 82 to 223 (+172%), peaking at 239 in 2017. The PRO-relate academic share rose from 7.3% to 11.6%, reaching a maximum of 12.9% in 2017. Spain showed the strongest growth, with PRO-related EP applications increasing from 57 to 265. The share in national EP applications grew from 5.9% in 2002 to 16.3% in 2020, outpacing the overall growth in EP applications from Spanish applicants.

Figure 10

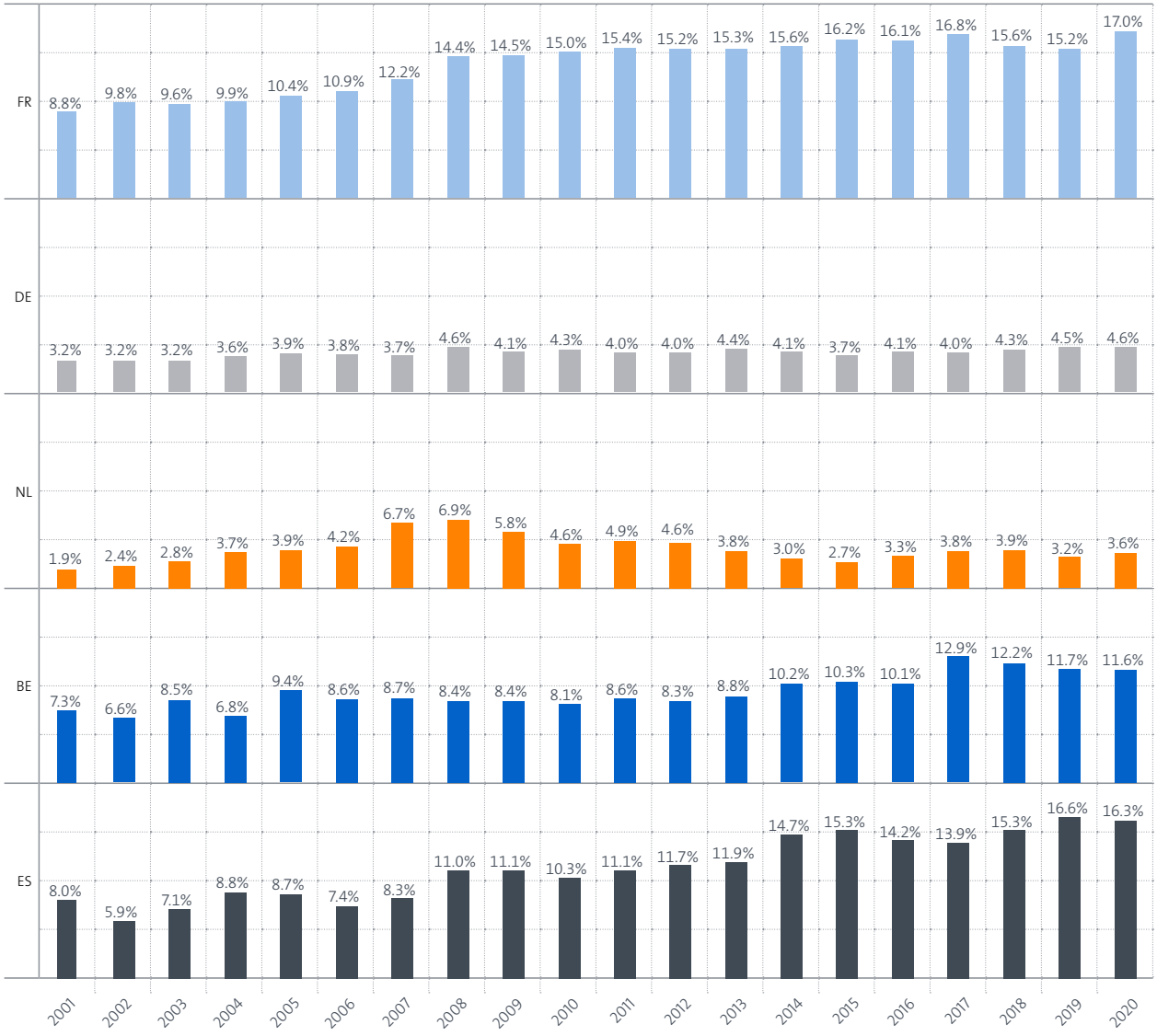
Absolute numbers of PRO-related European patent applications by priority year (2001-2020) for the top five European countries



Source: EPO - PATSTAT, Elsevier Scopus

Figure 11

Share of PRO-related European patent applications as percentage of total filed patent applications by priority year (2001-2020) for the top five European countries



Source: EPO - PATSTAT, Elsevier Scopus

3.2 Characteristics of PRO-related academic patents

This subsection analyses the characteristics of PRO-related academic patents. The data allow distinguishing between direct and indirect PRO contributions, i.e. direct and indirect academic patents, as well as the different types of PROs according to the OrgReg classification: Independent PROs, PNP, and PA (see Box 1). Direct academic patents are European patent applications filed directly in the name of the PRO or their knowledge transfer offices, where the institution maintains ownership of the IP. Indirect academic patents are applications filed by companies or other types of research institutions, but have at least one inventor affiliated with a European PRO.[2]

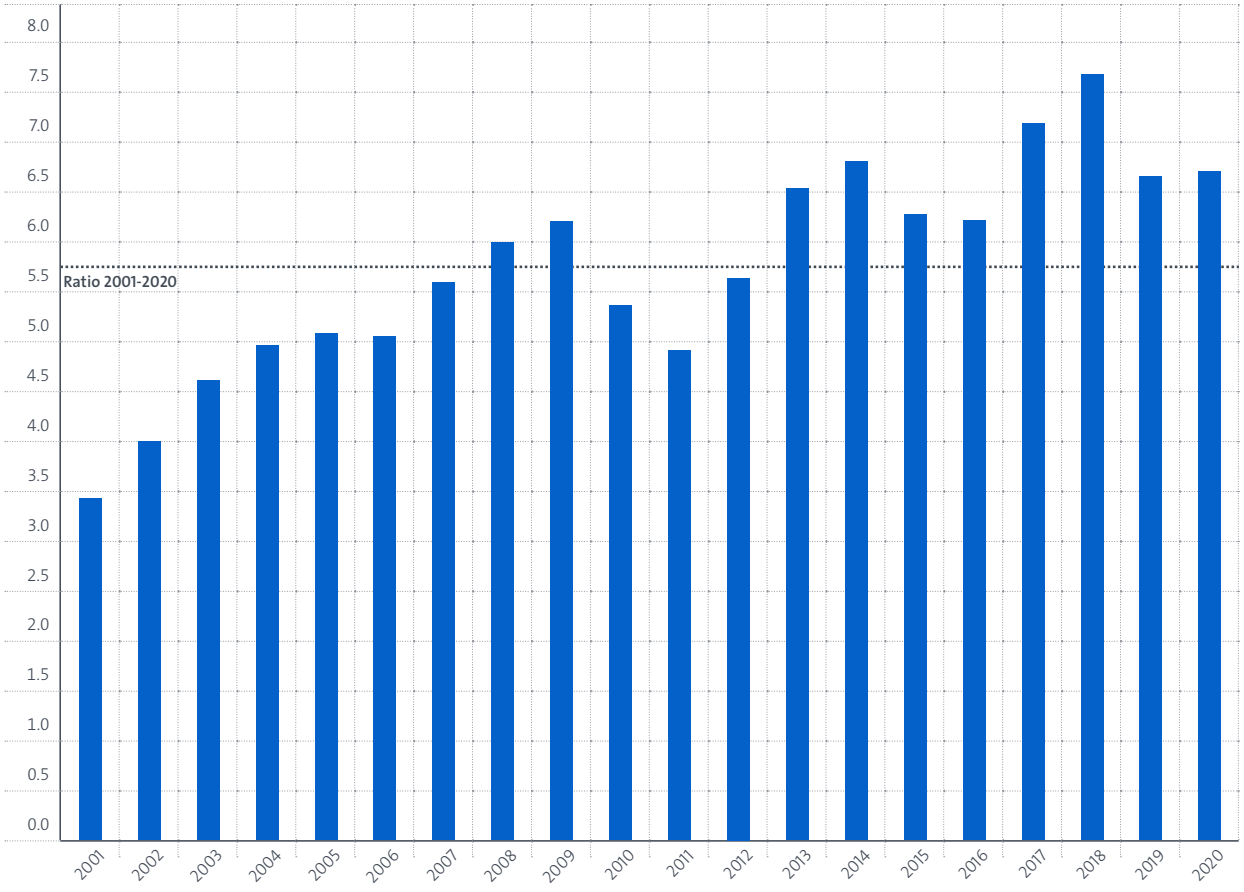
Between 2001 and 2020, 85.2% of European PRO-related academic patents were filed or co-filed directly by PROs. Indirect academic patents accounted for 14.8%, yielding an overall direct-to-indirect ratio of 5.8:1. The temporal analysis in Figure 12 reveals markedly different development patterns for these two categories of patent applications. Indirect PRO-related academic patents demonstrated remarkable consistency throughout the 20-year period, fluctuating narrowly between approximately 400-600 EP applications per year, suggesting that collaborative arrangements and informal knowledge transfer channels between PROs and external entities may have maintained a steady baseline level.

In contrast, direct PRO patent filings show substantial and sustained growth, increasing by 121% from just over 1 500 EP applications in 2001 to 3 320 in 2020. This possibly reflects a strengthening capacity and further strategic commitment of PROs towards direct IP ownership and research commercialisation. The direct-to-indirect ratios in Figure 12 illustrate this development, rising from just under 3.5 in 2001 to 6.7 in 2020, with the peak ratio of 7.7 in 2018.

2 All efforts have been made to capture indirect contributions, though some may not have been included due to data limitations. See Annex 1 for further details.

Figure 12

Ratio of direct versus indirect PRO-related academic patents by year, 2001-2020

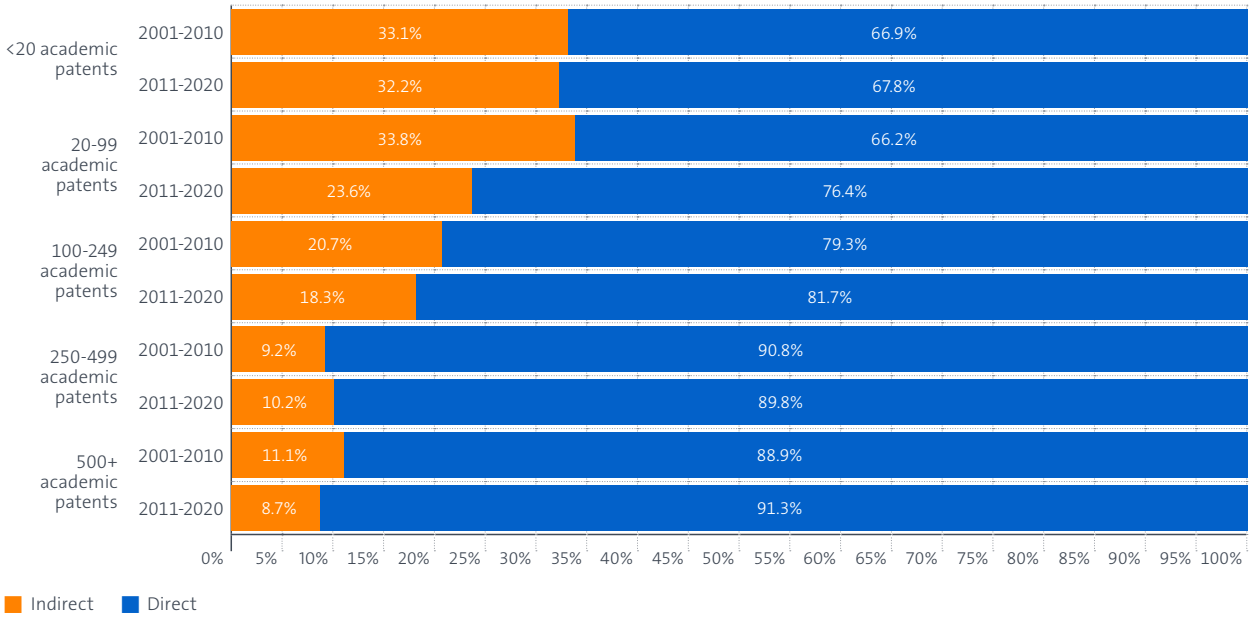


Source: EPO - PATSTAT, Elsevier Scopus

Figure 13 shows a clear size-dependent pattern in patenting contributions of European PROs. Smaller PROs (<20 academic patents over the 2001-2020 period) show the highest proportion of indirect patents at 33.1% in 2001-2010, which remains almost unchanged at 32.2% in 2011-2020. As PRO size increases, the share of indirect patents decreases systematically: medium-sized PROs (20-99 patents) show 33.8% indirect in the first period dropping significantly to 23.6% in the second period, while the largest PROs (500+ patents) maintain consistently low indirect shares around 11% in 2001-2010, which drops even further to 8.7% in 2011-2020. This pattern suggests that larger PROs have developed stronger institutional capacity for direct patent filing and commercialisation, while smaller organisations may rely more heavily on external partnerships or collaborative arrangements.

Figure 13

Share of direct and indirect PRO-related academic patents by PRO size group and time period (2001-2010 vs 2011-2020)

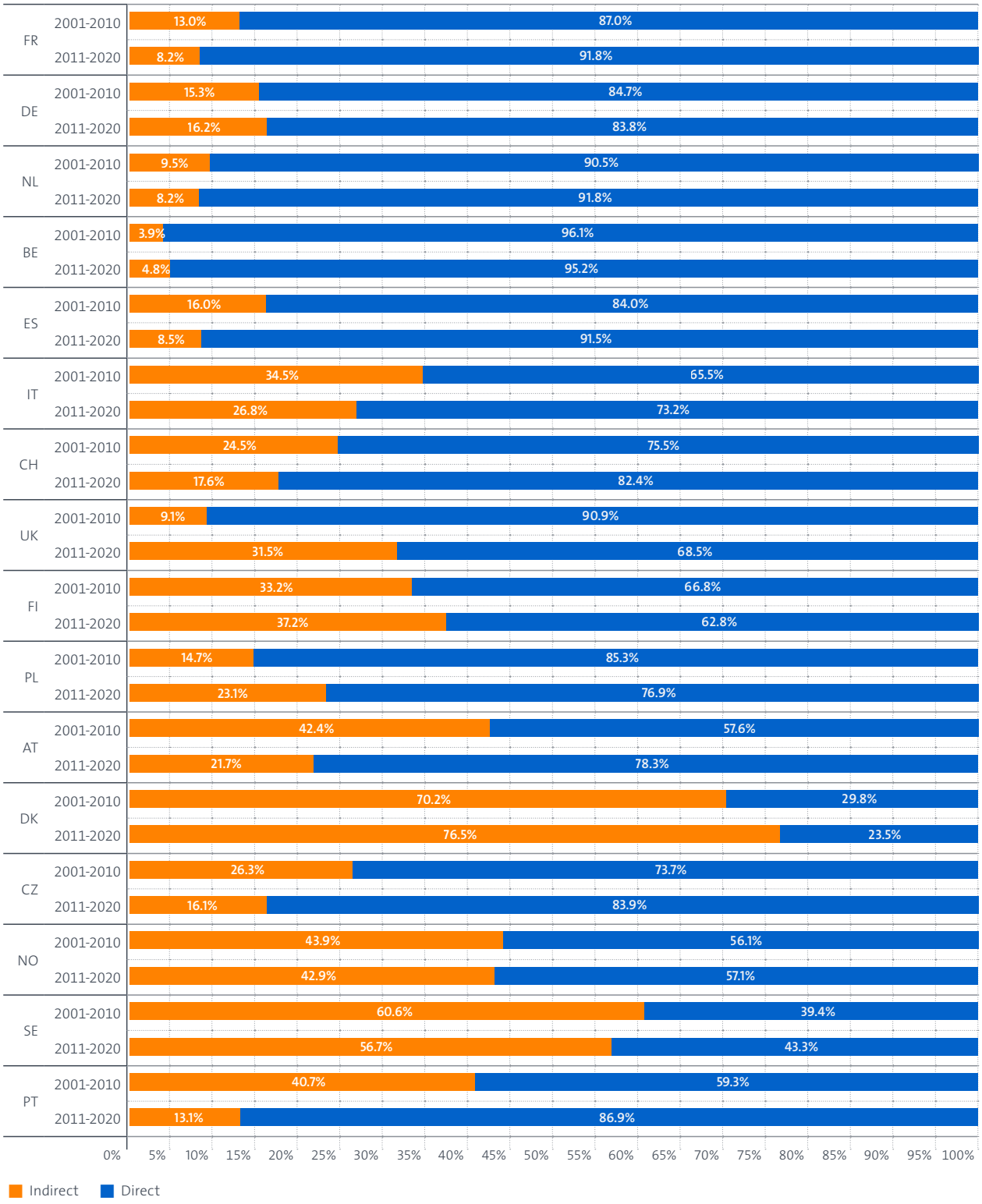


Source: EPO - PATSTAT, Elsevier Scopus

National patterns also show substantial heterogeneity in direct versus indirect academic patenting approaches. Most Western European countries demonstrate high direct academic patenting rates, with Belgium (95.2-96.1% direct), and the Netherlands (90.5-91.8% direct) showing particularly strong institutional ownership patterns. In contrast, several countries exhibit notably higher indirect patenting rates: Nordic countries like Denmark (70.2-76.5% indirect), Norway (42.9-43.9% indirect), Sweden (56.7-60.6% indirect) and Finland (33.2-37.2% indirect) show distinct patterns, as do some other European countries like Austria (42.4% indirect in 2001-2010) and Portugal (40.7% indirect in 2001-2010), although in both countries the shares of indirect patents declined significantly to 21.7% and 13.1%, respectively, in 2011-2020. The temporal trend generally favours increased direct patenting across most countries, with notable exceptions including Poland, where the indirect share increased from 14.7% to 23.1% and the UK, where the indirect share increased from 9.1% to 31.5%.

Figure 14

Share of direct and indirect PRO-related academic patents by country and time period (2001-2010 vs 2011-2020): Countries with less than 250 PRO-related EP applications in 2001-2020 were excluded



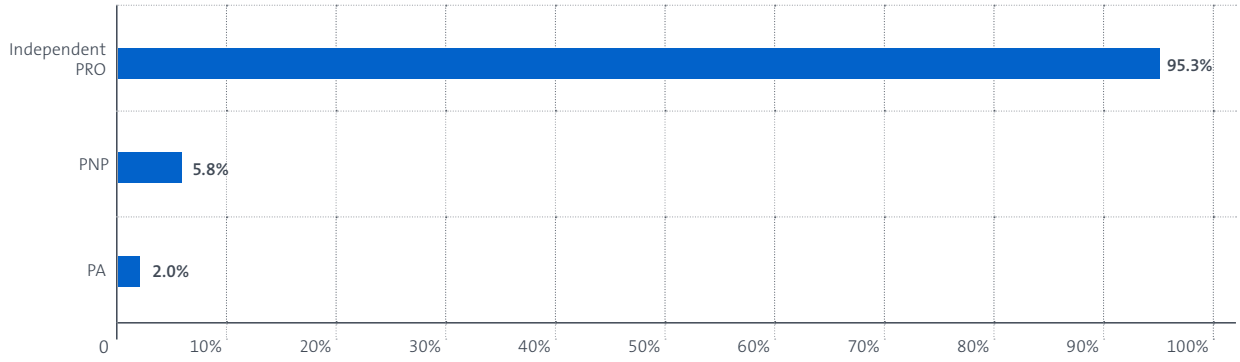
Source: EPO - PATSTAT, Elsevier Scopus

Overall, these patterns suggest that the evolution towards greater direct patenting is influenced by both institutional scale and national innovation system characteristics. The size effect likely reflects differences in technology transfer infrastructure, legal capacity and strategic IP management capabilities that larger PROs can develop more easily than smaller ones. Country-level variations may reflect different national policies regarding public research commercialisation, varying degrees of industry-academia collaboration or distinct institutional traditions in knowledge transfer.

The analysis of PRO-related patents by organisational type is presented in Figure 15. It reveals a clear dominance of Independent PROs, which contribute to 95.3% of all PRO-related patent applications. Private non-profit (PNP) organisations contribute to 5.8% of all applications, while Public administration entities (PA) contribute to only 2% of the total. These proportional shares have remained relatively stable throughout the observation period, with only minor fluctuations observed in the early 2000s when PNP organisations held a slightly higher share and Independent PROs correspondingly held a lower share. These results largely coincide with the levels of R&D investment by type of public organisations seen in Figure 5, which shows that PNP organisations receive relatively low R&D budgets compared to other PRO types.

Figure 15

Distribution of PRO-related European patent applications by organisational type, 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

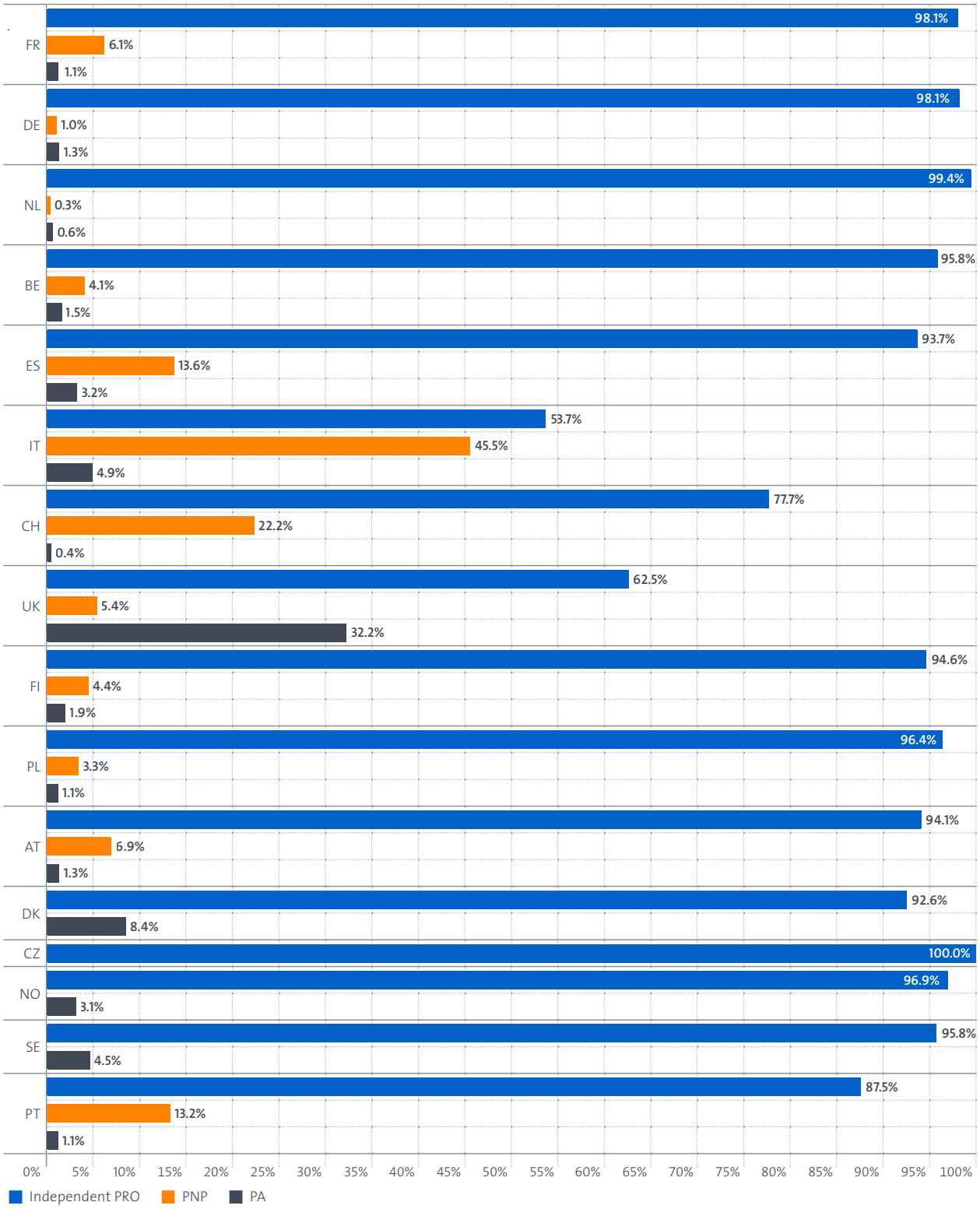
Note: The combined shares can exceed 100% because different PRO types may act as co-applicants on the same patent application or because researchers from one institution can be listed as inventors on a patent filed by another institution.

When examining countries with at least 250 PRO-related EP applications between 2001 and 2020, the dominance of Independent PRO institutions remains evident across most European nations (Figure 16), though notable variations exist in the relative importance of different organisational types within national innovation systems. PA entities show pronounced country-specific differences, with the United Kingdom demonstrating by far the highest PA contribution at 32.2% of national PRO-related patents, significantly exceeding all other countries. This is followed at much lower levels by Denmark (8.4%), Italy (4.9%), and Sweden (4.5%), while most other countries maintain even lower PA shares.

PNP organisations also exhibit a high degree of cross-country variation, with Italy showing an exceptionally high PNP share of 45.5%, making it the only country where PNP organisations rival Independent PRO institutions in patent contributions. Switzerland follows with a substantial 22.2% PNP contribution, while Portugal (13.2%), Spain (13.6%), and Austria (6.9%) also demonstrate above-average PNP participation. In contrast, countries such as Germany, the Netherlands and Belgium maintain relatively low PNP shares. These patterns reflect distinct national approaches to organising public research activities, with some countries like the UK and Italy showing greater reliance on PA and PNP organisations respectively.

Figure 16

Distribution of PRO-related European patent applications by organisational type and country (2001-2020): Countries with at least 250 PRO-related EP applications



Note: The combined shares can exceed 100% because different PRO types may act as co-applicants on the same patent application or because researchers from one institution can be listed as inventors on a patent filed by another institution

Source: EPO - PATSTAT, Elsevier Scopus

3.3 Technology specialisation of PROs' academic patents

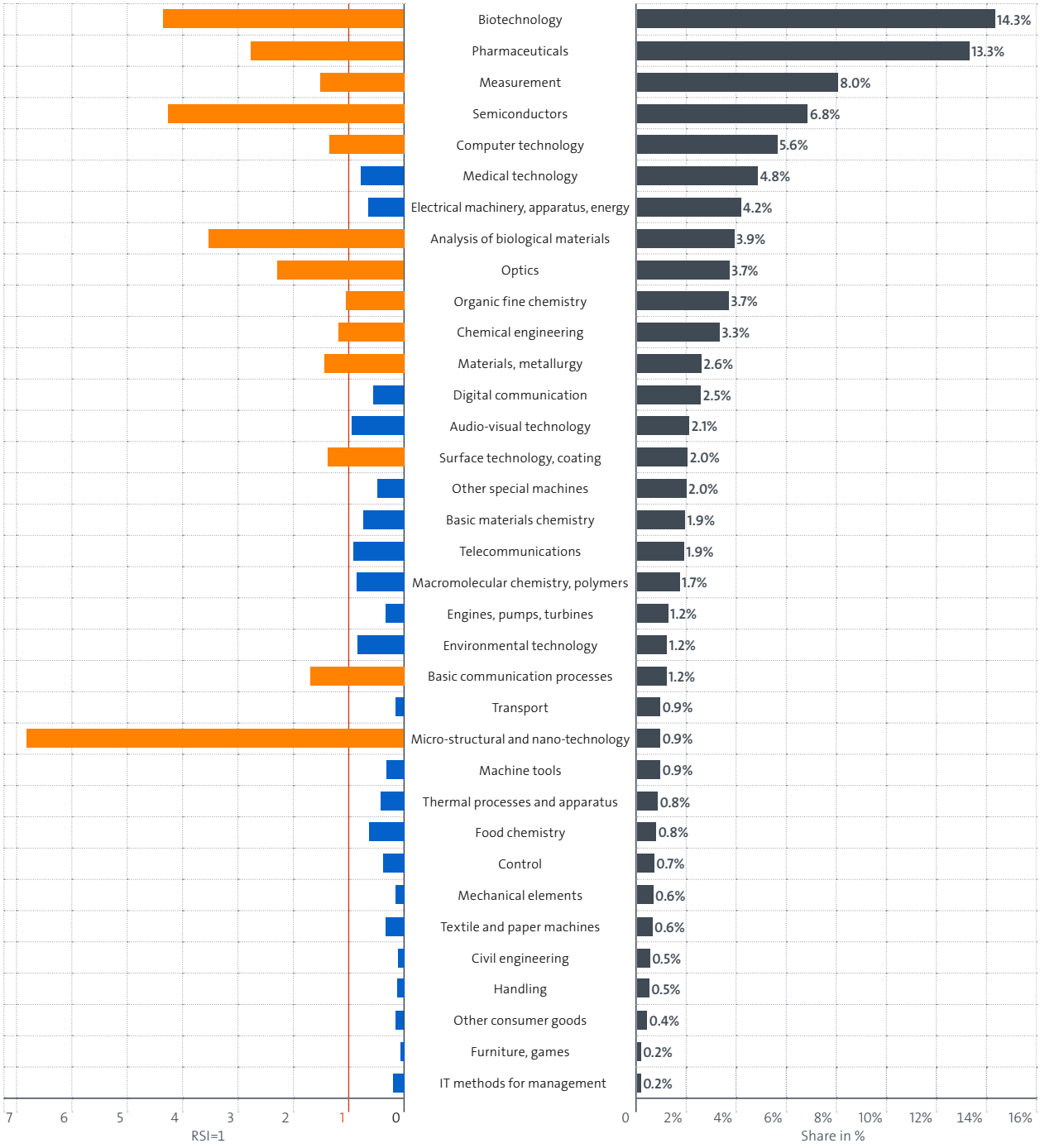
The following analysis investigates the technological distribution of PRO-related academic patents across 35 technology fields. These fields are related to five overarching technology sectors – Electrical Engineering, Instruments, Chemistry, Mechanical Engineering, and Other Fields – and created using the comprehensive technology concordance developed by Schmoch (2008) based on the International Patent Classification (IPC) system. This framework enables systematic classification and cross-sectoral comparison of innovation patterns.

The analysis in Figure 17 reveals a highly polarised technology specialisation pattern in European PRO-related academic patents, with pronounced concentration in science-based, research-intensive technologies and notable absence from conventional industrial domains. Life sciences establish overwhelming dominance, with biotechnology and pharmaceuticals together capturing 27.6% of all PRO-related academic patents – biotechnology alone showing exceptional specialisation (RSI ≈ 4.4) that far exceeds any other technology field. Knowledge-intensive sectors, including measurement technologies (8.0% share, RSI ≈ 1.5), semiconductors (RSI ≈ 4.3), computer technology, analysis of biological materials as well as optics demonstrate strong specialisation patterns (RSI > 1.0), reflecting PRO research competencies in advanced instrumentation and science-based technologies.

Conversely, conventional industrial applications show systematic underrepresentation, with mechanical engineering, civil engineering, machine tools, engines, pumps, turbines, transport technologies or consumer goods displaying both minimal patent shares (typically <1%) and low specialisation indices (RSI < 0.5). This creates a pronounced bifurcation between upstream research technologies and downstream industrial applications, suggesting European PROs function primarily as fundamental knowledge generators rather than integrated innovation partners for traditional industries.

Figure 17

Distribution of PRO-related academic patents across technology fields and Relative Specialisation Index (RSI), 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

Note: Left panel shows relative specialisation values, RSI (orange bars indicate RSI ≥ 1.0, representing specialisation; blue bars indicate RSI < 1.0). Right panel shows the percentage share of each technology field in total PRO-related academic patents using fractional counting in the case of several technology fields. The RSI is calculated as the share of EP applications identified as academic patents in that particular field relative to the share of the overall EP applications from European applicants in that particular field.

However, the aggregated view is dominated by large PROs. Figure 18 shows the relative specialisation patterns across different PRO size groups and reveals profound structural differences in how European PROs patent across technology fields. Large PROs (>500 academic patents) are operating as "technological generalists" with moderate specialisation across multiple technology domains rather than pursuing narrow focus areas. These institutions maintain strong presence in biotechnology and pharmaceuticals while simultaneously showing balanced engagement across semiconductors, measurement technologies and computer technology, suggesting they possess sufficient resources and infrastructure to sustain competencies across diverse research domains simultaneously. Medium-sized PROs (250-500 patents) exhibit more focused specialisation patterns, concentrating resources in several core technology domains with higher relative intensities in select areas rather than spreading across many fields.

Smaller PROs demonstrate the most extreme specialisation behaviours, showing deep concentration in very specific technology domains with binary patterns – either very high intensity in particular fields or virtual absence from others. For instance, small PROs show much higher relative intensity in technology fields closely related to engineering (e.g. civil engineering, textile and paper machines, medical technologies, machine tools and transport) while maintaining virtually no presence in all others. Similarly, some smaller PROs exhibit strong specialisation in food chemistry and organic fine chemistry, while largely avoiding other areas, illustrating their strategic focus on narrow technological niches where limited resources can generate competitive advantage.

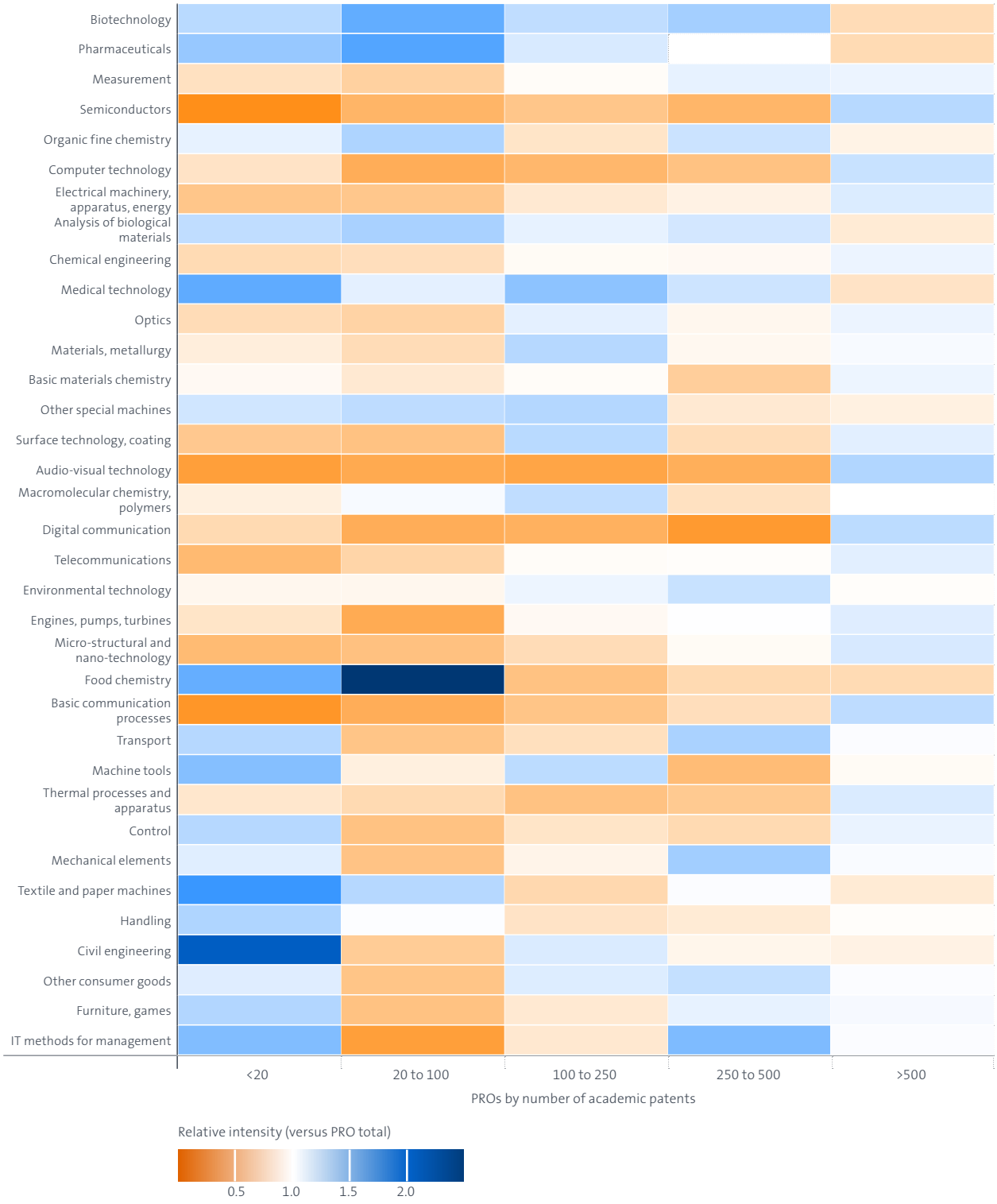
Figure 19 presents the variation in specialisation patterns of European PROs between the two periods 2011-2015 and 2016-2020. Pharmaceuticals emerged as the strongest growth area, showing the largest RSI increase (0.41) from an already-strong specialised position, indicating European PROs' potential strategic consolidation in pharmaceutical innovation. Telecommunications demonstrated transformative advancement (0.36 RSI increase) by crossing the specialisation threshold from underspecialised to specialised status, representing a fundamental shift in PROs' digital technology engagement. Digital communication also showed meaningful progress (0.2 increase), but remains below the specialisation threshold.

Life sciences experienced contrasting patterns despite their dominant positions. While specialisation in pharmaceuticals increased, biotechnology declined (-0.54 RSI decrease) but retained the highest specialisation level among larger technology fields, suggesting strategic diversification from an exceptionally concentrated position rather than abandonment of core competencies. Similarly, micro-structural and nano-technology showed the largest absolute decline (-0.85) but maintained highest specialisation of all tech fields.

Computer technology's decline (-0.4) is particularly noteworthy as it occurred from moderate baseline specialisation, representing significant strategic retreat from this field. Semiconductors remained relatively stable with modest decline while maintaining very high specialisation, and measurement technologies showed minimal change within their specialised domain.

Figure 18

Relative specialisation of European PROs by technology field and size group (2001-2020)



Source: EPO - PATSTAT. Elsevier Scopus

Figure 19

Change in specialisation levels (RSI) for PRO-related academic patents between 2011-2015 and 2016-2020

Source: EPO - PATSTAT, Elsevier Scopus

3.4 Mapping Europe's leading PROs

Figure 20 displays patent applications for the 16 leading European PROs that contributed at least 500 academic patents between 2001-2020 and a combined share of almost 70% (Figure 8), revealing a concentrated geographical distribution across just six countries. France dominates with seven institutions represented, followed by Germany with five. The remaining four countries each contribute one institution: Belgium with IMEC, the Netherlands with TNO, Spain with CSIC and Finland with VTT Technical Research Centre.

The temporal analysis across four consecutive five-year periods in Figure 20 reveals distinct patterns of patenting contribution evolution. Several PROs demonstrate consistent growth throughout all periods, most notably CNRS, which expanded from 1 616 applications in 2001-2005 to 3 177 in 2016-2020. Similarly, growth trajectories characterise CEA, rising from 1 131 to 2 804 applications, Fraunhofer Society increasing from 1 213 to 2 453, Belgium's IMEC more than doubling from 324 to 814 and INSERM nearly tripling from 532 to 1 408 applications over the two decades.

In contrast, some institutions exhibit more stable or even declining output patterns, with Institut Pasteur seeing a reduction in its activity from 213 to 171 per period. Other organisations show moderate fluctuations, including Max Planck Society, which remained relatively stable between 514 and 576 applications across periods, TNO, which peaked at 1 057 applications in 2006-2010 before moderating to 724 in the most recent period and Spain's CSIC, which grew from 247 to 345 applications. Finland's VTT demonstrated variable but generally upward trending activity, rising from 111 to 260 applications. The most pronounced declining trend appears at Forschungszentrum Jülich, which decreased from 293 applications in 2001-2005 to 154 in 2016-2020.

These figures illustrate both the scale and diverse trajectories of patenting activity among Europe's major PROs, though it is important to note that these data do not necessarily represent overall innovation performance, as PROs contribute to innovation through multiple channels beyond patenting, and individual institutional patenting strategies can significantly influence these counts and may have evolved over the analysed timeframe (see Boxes 3 and 4 explaining TNO's and CSIC's patenting strategy evolution). For example, CNRS frequently files patents in collaboration with its research partners – often universities – a pattern that will become evident in the analysis of co-applicants in Chapter 5.1.

Figure 20

Total and five-year academic patent contributions of leading European PROs (2001-2020)

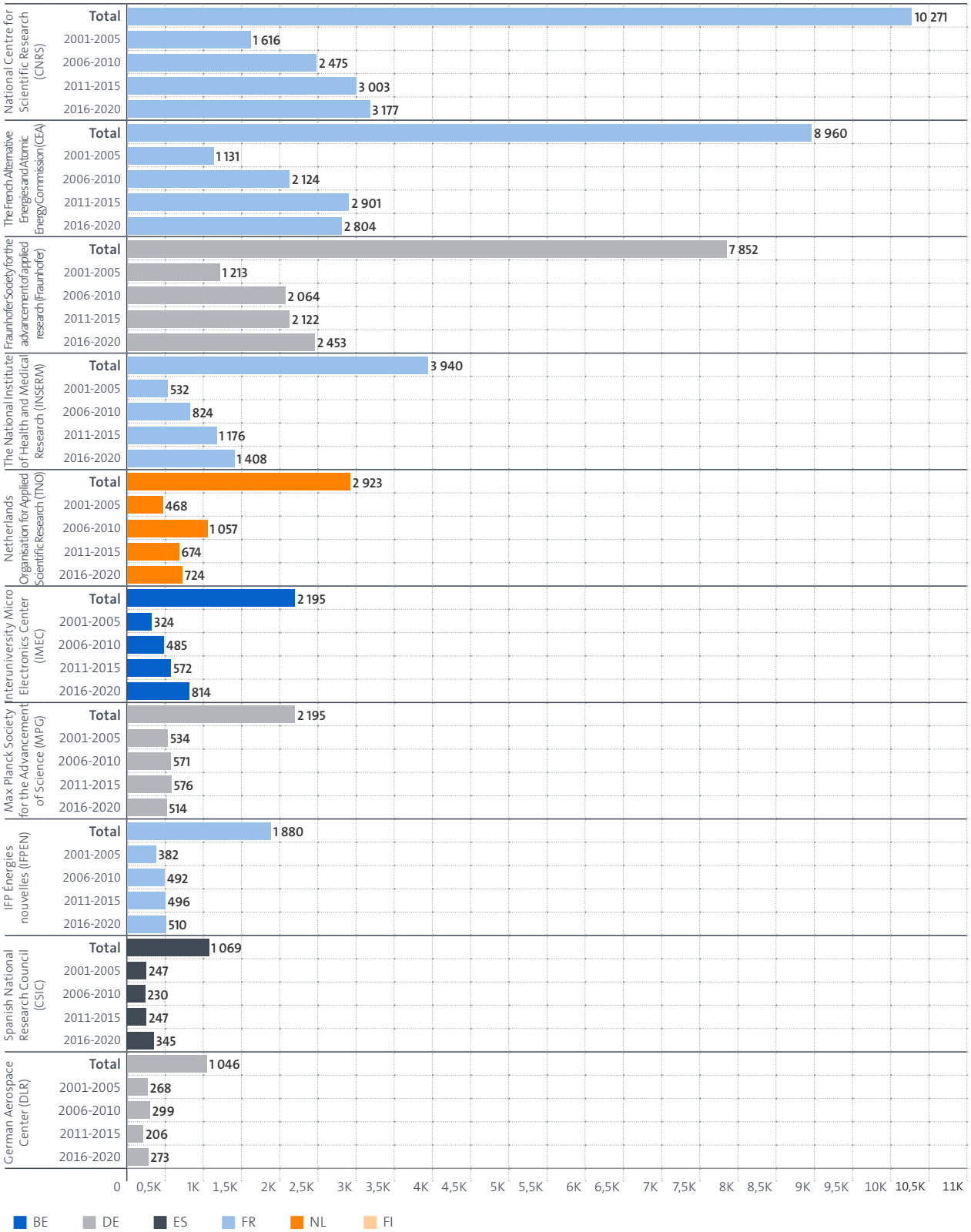
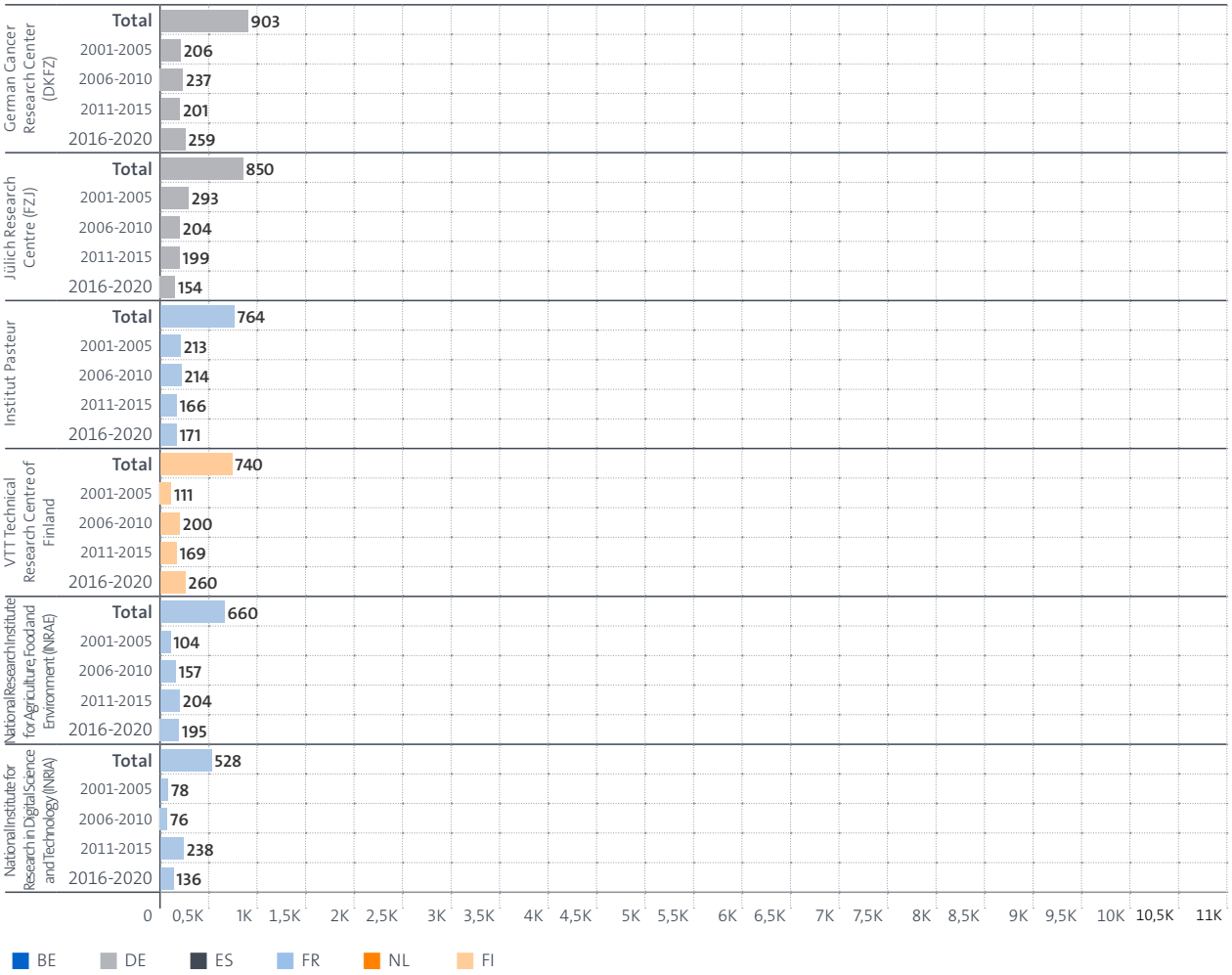


Figure 20 cont.



Source: EPO - PATSTAT, Elsevier Scopus

BOX 3: Bridging the Gap: TNO's Role in Technology Transfer and Innovation

As the largest PRO in the Netherlands, TNO is deeply rooted in technology transfer. Its mission is to ensure that innovations move beyond the lab and into society. Central to this effort is the creation of spin-off companies that translate scientific knowledge into practical solutions. Through TNO Ventures, the organization supports startups that align with strategic goals, offering access to expert knowledge, advanced technologies, and high-end facilities in fields such as AI, semiconductors, medical technology, and quantum technologies.

TNO Ventures

TNO Ventures plays a pivotal role by bridging the 'valley of death'—the critical mid-range technology readiness level (TRL) stages where many promising technologies stall. By launching spin-offs and supporting startups through this phase, TNO accelerates the journey from research to scalable application, ensuring that innovations reach the market and deliver societal and economic value.

Since launching its Tech Transfer Program in 2017, TNO has built a portfolio of over 45 spin-off companies, with four new ventures launched in 2024 alone. These companies span sectors such as high-tech industry, energy, healthtech, and enterprise software, and collectively represent a valuation of €664 million. In 2024, they raised €200 million in funding and accounted for 8.7% of all capital invested in Dutch startups. Together, they have created over 700 jobs. With 25 additional tech transfer projects in the pipeline, TNO aims to launch several new spin-offs annually.

From innovation to impact

TNO's involvement doesn't end at launch. It remains engaged during later phases of implementation, helping partners navigate manufacturability, regulatory constraints, and market dynamics. Whether through direct collaboration, strategic partnerships, or temporary equity participation via TNO Ventures B.V., TNO offers flexible pathways for startups to grow without compromising financial stability.

One of the standout successes is Nearfield Instruments. As microchips become increasingly complex, traditional metrology tools struggle to keep pace. Nearfield, a TNO spin-off, developed a breakthrough nanoscale metrology system that enables precise, non-destructive measurement of chip structures during production. In 2024, the company raised €135 million from global investors. With patent applications linked to TNOs and licensing agreements firmly in place, Nearfield exemplifies how long-term vision, technical excellence, and strategic support can turn deep-tech innovation into real-world impact.

Impact story: Measuring advanced microchips: think Nearfield Instruments:
https://publications.tno.nl/publication/34644260/uW90I2SI/TNO-2025-10771.pdf

Table 2

Various metrics of leading European PROs

PRO name	Country	Number of PRO-related academic patents (2001-2020)	Share of European PRO-related academic patents	Share of national PRO-related academic patents	Share of EP applications filed by national applicants	Ratio scientific publications in STEM and number of academic patents (2001-2020)
National Centre for Scientific Research (CNRS)	FR	10 271	16.3%	40.5%	5.6%	26.1
The French Alternative Energies and Atomic Energy Commission (CEA)	FR	8 960	14.2%	35.3%	4.9%	3.1
Fraunhofer Society for the advancement of applied research (Fraunhofer)	DE	7 852	12.5%	43.0%	1.7%	8.2
The National Institute of Health and Medical Research (INSERM)	FR	3 940	6.3%	15.5%	2.2%	21.3
Netherlands Organisation for Applied Scientific Research (TNO)	NL	2 923	4.6%	76.9%	3.0%	6.8
Interuniversity Micro Electronics Center (IMEC)	BE	2 195	3.5%	71.2%	6.7%	7.7
Max Planck Society for the Advancement of Science (MPG)	DE	2 195	3.5%	12.0%	0.5%	86.0
IFP Energies nouvelles (IFPEN)	FR	1 880	3.0%	7.4%	1.0%	3.4
Spanish National Research Council (CSIC)	ES	1 069	1.7%	35.7%	4.2%	79.5
German Aerospace Center (DLR)	DE	1 046	1.7%	5.7%	0.2%	35.8
German Cancer Research Center (DKFZ)	DE	903	1.4%	4.9%	0.2%	36.0
Institut Pasteur	FR	850	1.4%	4.7%	0.2%	25.2
Jülich Research Centre (FZJ)	DE	764	1.2%	3.0%	0.4%	51.1
VTT Technical Research Centre of Finland	FI	740	1.2%	82.6%	2.2%	22.0
National Research Institute for Agriculture, Food and Environment (INRAE)	FR	660	1.0%	2.6%	0.4%	1.9
National Institute for Research in Digital Science and Technology (INRIA)	FR	528	0.8%	2.1%	0.3%	48.5

Source: EPO - PATSTAT, Elsevier Scopus

Table 2 presents additional metrics that control for each organisation's overall patenting volume – such as what share of its country's PRO-related academic patents it produces, how many European patent filings it represents nationally and its ratio of publications to EP patent applications – and reveal different strategic profiles. Taken together, these metrics illustrate that beyond scale, European PROs pursue a spectrum of research and patenting strategies – ranging from publication-intensive basic science to patent-driven applied research – which has implications for how each organisation contributes to both national innovation systems and the broader European patent landscape.

While CNRS and CEA continue to dominate in absolute numbers, their 40.5% and 35.3% shares of French PRO-related academic patents highlight their central national roles, compared with Max Planck's modest 12% share in Germany's PRO-related academic patents despite its strong publication record.[3] VTT and TNO likewise exhibit high national patent shares (82.6% and 76.9% respectively), demonstrating their outsized influence on Finnish and Dutch patenting despite more modest total contributions. In national European patent filings, IMEC's 6.7% share of Belgian applications far exceeds any other organisation, underlining Belgium's reliance on its premier microelectronics centre, whereas Max Planck and German Aerospace Center, for example, account for less than 0.5% of German EP filings.

3 Since CNRS and CEA are also contributors to the same EP applications, their total number of PRO-related academic patents between 2001 and 2020 is 18 444. Their combined contribution to all French PRO-related academic patents is 73.6%.

BOX 4: Spanish National Research Council (CSIC)

The Spanish National Research Council (CSIC) is the main public research organization in Spain and one of the most prominent in Europe. With a network of 123 institutes and centres spread across the country, more than 17 000 staff members, and scientific activity covering all areas of knowledge, the CSIC is a cornerstone of Spain's science, technology, and innovation system.

In recent years, the institution has launched various strategic initiatives and promoted innovation policies to maximize the impact of the knowledge generated in its institutes and laboratories:

- **Diversification in results protection.** Traditionally, CSIC technologies were protected through patents and plant variety rights. Today, the institution has adopted a broader strategy, incorporating mechanisms such as trade secrets, software registration, the deposit and custody of biological materials, and their combination with patents. This diversification has reinforced the flexibility of protection strategies without altering CSIC's leadership position: it remains the top Spanish applicant for European and international (PCT) patents, as well as the leading patent applicant in Spain.
- **Increase in the number of European patent applications**. CSIC usually protects its inventions by first filing a priority patent in Spain, except when developed in collaboration with another European institution, in which case a European patent is filed directly. Patents with high transfer potential are then extended internationally through the PCT system. In cases where technologies are licensed, it is the licensee company that decides and undertakes the filing of the European patent, while CSIC pursues this route for those considered strategically relevant. The steady growth in European applications reflects stronger international collaborations and CSIC's success in transferring technologies for their exploitation at the international level.
- **Use of the Unitary Patent.** The CSIC makes use of the Unitary Patent for those patents granted in Europe, in order to extend protection to European Union countries. This approach streamlines administrative management and reduces costs, particularly when coverage includes more than four countries
- **Promotion of socially responsible licenses.** CSIC has developed responsible licensing policies, particularly in the health sector, ensuring that technologies with

high social demand are not transferred under exclusive regimes to companies unable to guarantee broad supply. During the COVID-19 pandemic, the institution collaborated with international initiatives such as the Medicines Patent Pool (MPP) and the World Health Organization (WHO) to ensure access to its developments in countries with urgent health needs.

- **Boosting effective knowledge transfer to society.** In 2023, CSIC created CONVERGE (https://converge.csic.es/), its open innovation hub, designed to strengthen the transfer of knowledge to society and build trust with actors in the innovation ecosystem. This space brings together the challenges and needs of society and industry with CSIC's transformative potential, jointly generating new knowledge, technologies, and solutions. As part of this effort to enhance the visibility and impact of its research, CSIC has also published a catalogue featuring its 100 most relevant and promising technologies (https://www.csic.es/sites/default/files/2025-07/CATALOG%20CSIC%20OT_2025_EN.pdf), aimed at facilitating their transfer and generating social impact.

- **Strengthening public-private collaboration** through the development of co-creation and co-development projects with companies to promote solutions to global challenges. As a result, between 2020 and 2024, CSIC formalised 430 license agreements for the exploitation of its technologies.

- **Creation and consolidation of spin-offs.** Over the past five years, CSIC has established an average of ten Spin off companies per year, reaching a total of 109 spin-offs, with a survival rate of 82% over the last seven years. Among them, 81% hold at least one national or international patent application, consolidating this asset as the most common element in their business growth strategy.

- **Promoting knowledge transfer also to the public sector** through the exchange of scientific knowledge with public administrations and the development of initiatives that generate impact on public policies.

- **Gender perspective in innovation.** CSIC is a pioneer in incorporating gender equality criteria into research results protection. Currently, 86% of its patents include at least one woman inventor and 40% of the inventors listed in its applications are women, positioning the institution as an international benchmark in this field.

Through these initiatives, CSIC has not only strengthened its role as a generator of scientific knowledge but has also established itself as a key player in the valorisation and transfer of research results, contributing to economic, social, and technological progress in Spain and beyond its borders.

Figure 21 shows academic patents-to-STEM publication ratios for the top ten European PROs and reveals divergent institutional missions and national trajectories over the 2001-2020 period.[4] French PROs show strong upward momentum: CEA's ratio rose from 0.171 to 0.790 and IFP-Énergies Nouvelles (IPFEN) climbed from 0.287 to 0.417, while CNRS increased modestly from 0.036 to 0.052 and INSERM from 0.039 to 0.074. Among German organisations, Fraunhofer's ratio remained relatively stable (0.169 to 0.138), while Max Planck's ratio declined from 0.016 to 0.012 and the German Aerospace Center dropped sharply from 0.061 to 0.024. TNO in the Netherlands first grew (0.112 to 0.191) before slightly retreating, and IMEC in Belgium steadily increased from 0.12 to 0.21. CSIC in Spain fluctuated at levels in the range of 0.013 to 0.019. It should be noted, however, that these ratios only capture patents filed at the EPO, and therefore reflect filing strategies and institutional practices—organisations such as CSIC patent extensively at national offices, which is not reflected in these figures These patterns show how French institutions have progressively oriented towards patenting at the EPO alongside their STEM outputs, while the ratios of German institutions stagnated or declined. Other PROs exhibit diverse strategies ranging from sustained academic patent intensity at IMEC to more publication-centric profiles like Max Planck's.

4 The analysis is based on EP applications and does not consider national patent applications, the ratio is therefore only representative of the strategy of these organisations with regards to filing at the EPO.

Figure 21

Distribution of the ratio of academic patents filed at the EPO and STEM academic publications for the top ten PROs by five-year periods

Source: EPO - PATSTAT, Elsevier Scopus

4. Benchmarking European research institutions: Academic patenting profiles of PROs, universities and research hospitals

This chapter examines the roles of PROs, universities and research hospitals in Europe's academic patenting landscape by mapping and comparing their contributions to EP applications from 2001 to 2020. It uses the methodology for distinguishing direct and indirect academic patents from Box 1 and outlines the evolution of institutional engagement in European patenting activities. By framing these patterns within different national contexts and institutional models, the chapter provides evidence of how research institutions shape Europe's innovation ecosystem.

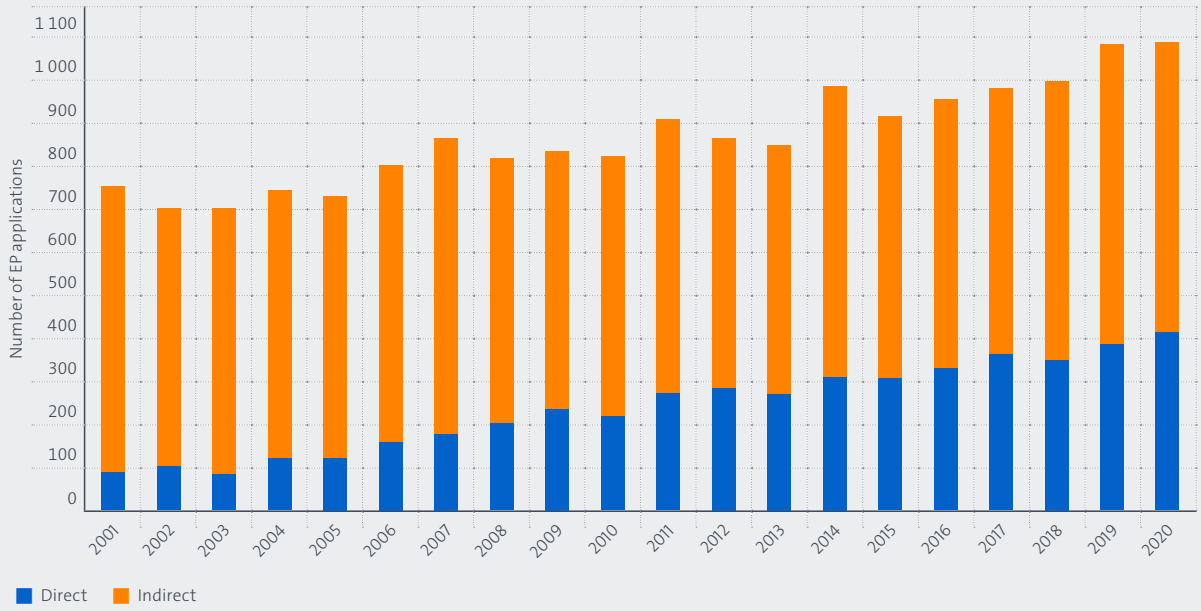
BOX 5: Academic patent landscape of European research hospitals

Research hospitals constitute vital innovation hubs within the European research and development ecosystem, driving medical technology advancement and knowledge transfer. European research hospitals contributed to 17 434 EP applications between 2001 and 2020, demonstrating sustained growth from approximately 700-750 applications in the early 2000s to nearly 1 100 in 2020 (Figure 22). This growth trajectory was primarily driven by direct patent applications – where research hospitals themselves serve as the applicant – which increased substantially from around 90 EP applications in 2001 to over 400 in 2020. Meanwhile, indirect applications – where hospital researchers serve as inventors but another entity (such as a company or university, to which research hospitals are often associated) acts as the applicant – remained relatively stable at approximately 600-700 applications annually throughout the period.

Despite the growth in direct filing, indirect applications continued to dominate research hospital contributions to academic patenting, accounting for 72.5% of all applications over the two-decade period compared to 27.5% for direct applications. However, the relative composition shifted notably over time: while indirect patents represented over 85% of contributions in the early 2000s, their share declined to approximately 62% by 2020, with direct patents correspondingly increasing from roughly 15% to 35% of the total. This trend indicates research hospitals' growing institutional capacity for direct patent filing.

Figure 22

Number of direct and indirect European academic patents with research hospital involvement, 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

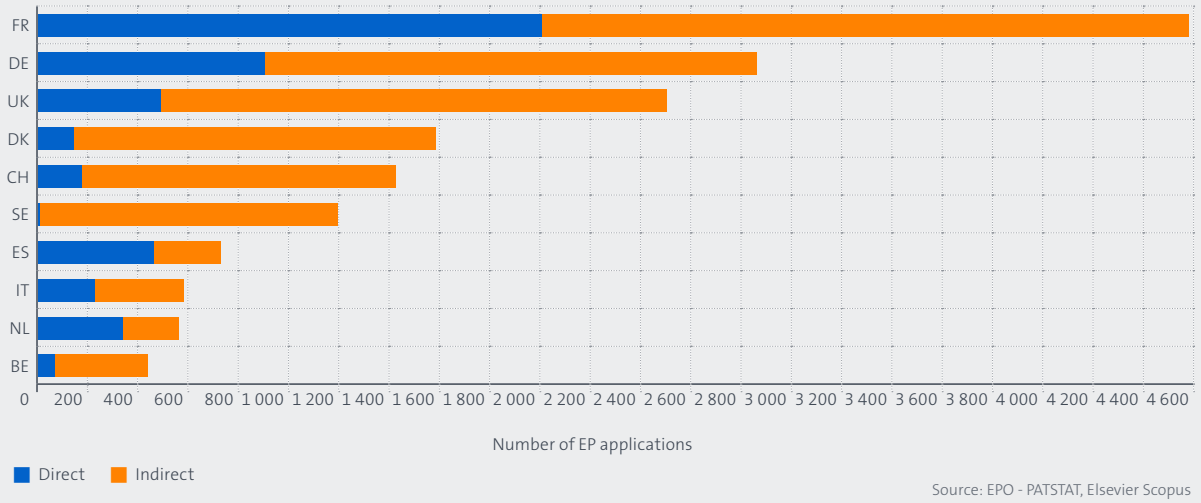
Based on the available data, France dominates the European research hospital patent landscape with 4 575 applications, followed by Germany (2 858) and the UK (2 500), collectively representing over 56% of all academic patents from research hospitals (Figure 23). The Nordic and smaller European nations – Denmark (1 579), Sweden (1 190) and Switzerland (1 422), – form a significant middle tier, while Southern European countries Spain (726) and Italy (577), along with the Netherlands (559) and Belgium (433), complete the ranking.

The direct-to-indirect patent ratios reveal national differences in research hospital patenting strategies, too. The Netherlands (60% direct) and Spain (57% direct) demonstrate the highest institutional capacity for direct patent filing, suggesting strong technology transfer infrastructures within their research hospitals. France (43.8%), Germany (31.6% direct) and Italy (38.8% direct) maintain a relatively balanced approach.

In contrast, the Nordic countries exhibit extremely low direct patent shares: Sweden with less than 1% direct patents, Denmark at 8.9%, alongside Switzerland at 12.1%, Belgium (14.8%) and the UK (19.6%). This pattern suggests that research hospitals in these countries contribute to academic patenting primarily through affiliated researchers who are listed as inventors, while patent ownership is typically retained by other entities such as public research organisations and universities (see co-applicant analysis in Chapter 5.1). This is consistent with the fact that many research hospitals are affiliated with – or even integrated into – universities or PROs, with patent applications often being filed by the parent institution.

Figure 23

Number of academic patents from European research hospitals for top countries, 2001-2020



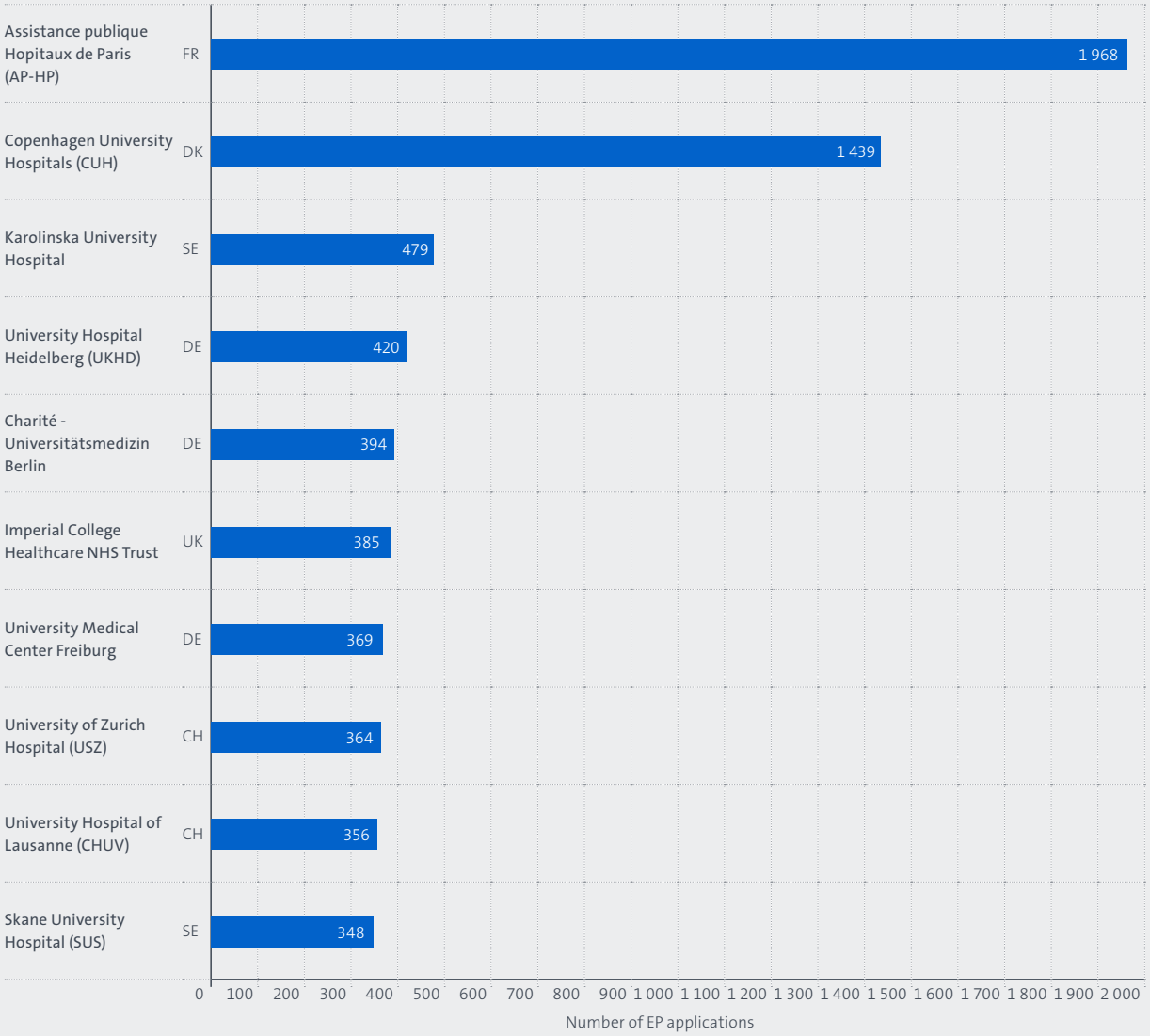
Source: EPO - PATSTAT, Elsevier Scopus

The list of top applicants in Figure 24 consists of large European research hospitals from major healthcare nations. Assistance Publique Hôpitaux de Paris (AP-HP) leads with 1 968 EP applications. This represents over 11% of all European academic patents from research hospitals and almost 44% of the French ones, reflecting its status as Europe's largest teaching hospital system. Copenhagen University Hospitals (CUH) follows with 1 439 applications, representing Denmark's comprehensive university hospital network.

Sweden's Karolinska University Hospital, with 479 EP applications is third, followed by the German and Swiss institutions, University Hospital Heidelberg (420), Charité - Universitätsmedizin Berlin (394), University Medical Center Freiburg (369),University of Zurich Hospital (364), University Hospital of Lausanne (356) and, forming a strong mid-tier group. Sweden's Skane University Hospital (348) and the UK's Imperial College Healthcare NHS Trust (6th with 385 academic patents) complete the top ten.

Figure 24

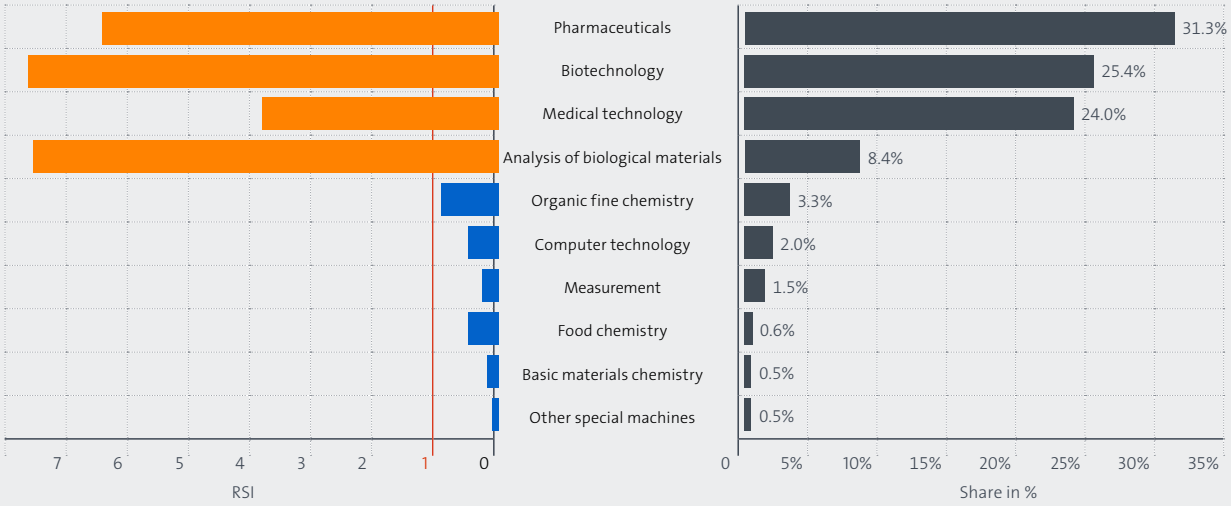
Total academic patent contributions of leading European research hospitals, 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

Figure 25

Distribution of academic patents from research hospitals across technology fields (with at least 0.5% share) and Relative Specialisation Index (RSI), 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

Research hospitals demonstrate a very pronounced technology concentration, with almost 90% of their academic patents concentrated in just four medical-related fields (Figure 25). Pharmaceuticals dominate with 31.3% of all patents, followed by biotechnology (25.4%), medical technology (24.0%) and analysis of biological materials (8.4%). This is also reflected in the specialisation pattern, with extremely high RSI values in all four areas, indicating these technology fields are core competencies.

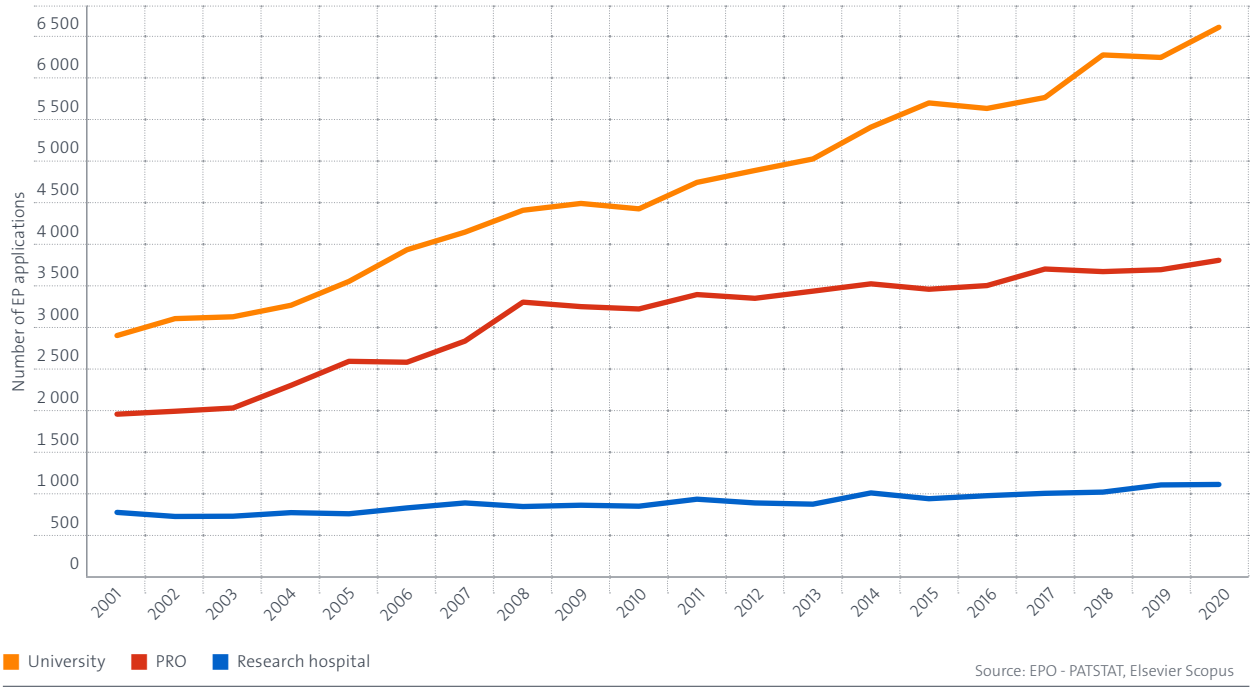
All other technology fields display systematic underspecialisation with RSI values well below one. Unlike the broader PRO landscape that shows some diversification across knowledge-intensive fields such as measurement, semiconductors or computer technology, research hospitals exhibit focused expertise in life sciences and medical applications. The pattern reinforces research hospitals' role as specialised medical innovation hubs within the European research ecosystem.

4.1 Trends in direct and indirect academic patents

Patent applications involving European research institutions, as applicants or through researchers that appeared as inventors on a patent application at the EPO, amounted to almost 137 000 EP in the period 2001 and 2020. Their analysis reveals significant growth and shifting dynamics. The total research institution involvement increased from 4 628 to 8 691 applications, representing 87.8% growth with a 3.4% compound annual growth rate (CAGR). The total research institution contribution to European patenting increased from 8.4% to 12.3%, with direct patenting driving virtually all growth while indirect contributions plateaued throughout the period. This shift reflects European research institutions' evolution from primarily supporting industry-led innovation through researcher involvement to becoming major patent applicants in their own right, with greater institutional responsibility in commercialising research outcomes.

Figure 26

Trends in academic patents by different types of European research institutions, 2001-2020

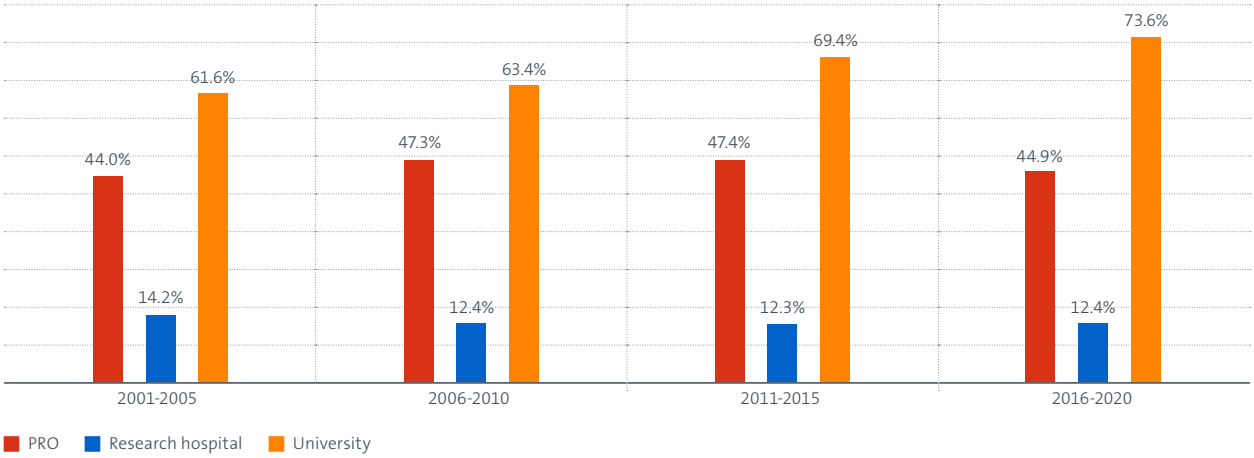


Source: EPO - PATSTAT, Elsevier Scopus

Figure 26 illustrates the trend in European academic patents from different types of research institutions between 2001 and 2020. Universities demonstrated exceptional growth, achieving 129.2% total increase with a 4.46% CAGR, expanding from 2 859 EP applications in 2001 to 6 553 in 2020. Their contributions in total European academic patents grew steadily from 61.6% in 2001-2005 to 73.6% in 2016-2020 (Figure 27) – their growth trajectory shows consistent acceleration across all periods. PROs maintained substantial but fluctuating contributions with 95.6% total growth and 3.6% CAGR, growing from 1 950 to 3 815 applications. Their shares in total European academic patenting rose from 44% in 2001-2005 to 47.4% in 2011-2015 before moderating to 44.9% in 2016-2020, demonstrating their continued importance while ceding relative ground to universities. Research hospitals displayed modest expansion of 44.5% with 2% CAGR, increasing from 755 to 1 091 applications between 2001 and 2020. Their total contribution in European academic patenting declined from 14.2% in 2001-2005 to around 12.4% in 2006-2010 and stabilised in the following periods, indicating their specialised but limited role in the broader European academic patent landscape. Notably, the combined individual contributions of all three institution types exceed 100% in each period – reaching 130.9% by 2016-2020 – indicating that many patent applications involve collaboration between different types of European research institutions as co-applicants or co-inventors (see Chapter 5.1 for an analysis of co-application patterns).

Figure 27

Evolution of market shares by research institution type as percentage of total European academic patents from 2001-2020, by five-year periods



Source: EPO - PATSTAT, Elsevier Scopus

Note: Multiple institutions may contribute to a single patent application, either as (co-)applicants or through (co-)inventorship. As a result, the aggregated contributions from different types of research institutions typically exceed 100%.

The following Figure 28 shows the difference between universities, PROs and research hospitals in academic patenting regarding direct versus indirect contributions. This analysis reveals fundamentally different institutional approaches to patent ownership across the European research sector.

Universities experienced a notable change in patent filing behaviour, moving from predominantly indirect contributions (3.7% indirect vs 1.7% direct in 2001-2005) to nearly balanced direct and indirect participation by 2016-2020 (4.4% direct vs 4.3% indirect), with the direct-to-indirect ratio increasing from 0.5 to 1.0. This trend is analysed in more detail in the 2024 study prepared by the EPO Observatory on patenting and innovation in universities. This occurs due to several reasons, among others, the abolition of the so-called Professor's Privilege in several European countries.[5] By 2016-2020, universities' direct patent share (4.4%) closely approached PROs' direct share (4.6%), indicating convergence in direct patent filing activity between these institution types. Indeed, in 2020 universities contributed to more direct academic patents at the EPO than European PROs. This change reflects universities' increased participation as patent applicants rather than solely as research contributors to patents filed by industry or other research institutions.

PROs maintained consistent direct patent filing preferences throughout the analysed period, showing the highest proportion of direct relative to indirect contributions among all research institution types. PRO direct patenting increased from 3.2% to 4.6% while their indirect contributions remained relatively stable at 0.7-0.8%, resulting in direct-to-indirect ratios rising from 4.4 to 6.9 between the periods.

Research hospitals maintained higher levels of indirect compared to direct patent contributions, showing preference for contributing to patents filed by companies or other institutions rather than filing as primary applicants. While remaining predominantly indirect throughout (0.9% vs 0.5% direct in 2016-2020), research hospitals showed significant growth in direct patent applications, improving their direct-to-indirect ratio to 0.5 in 2016-2020 while the share of their indirect contributions declined slightly.[6]

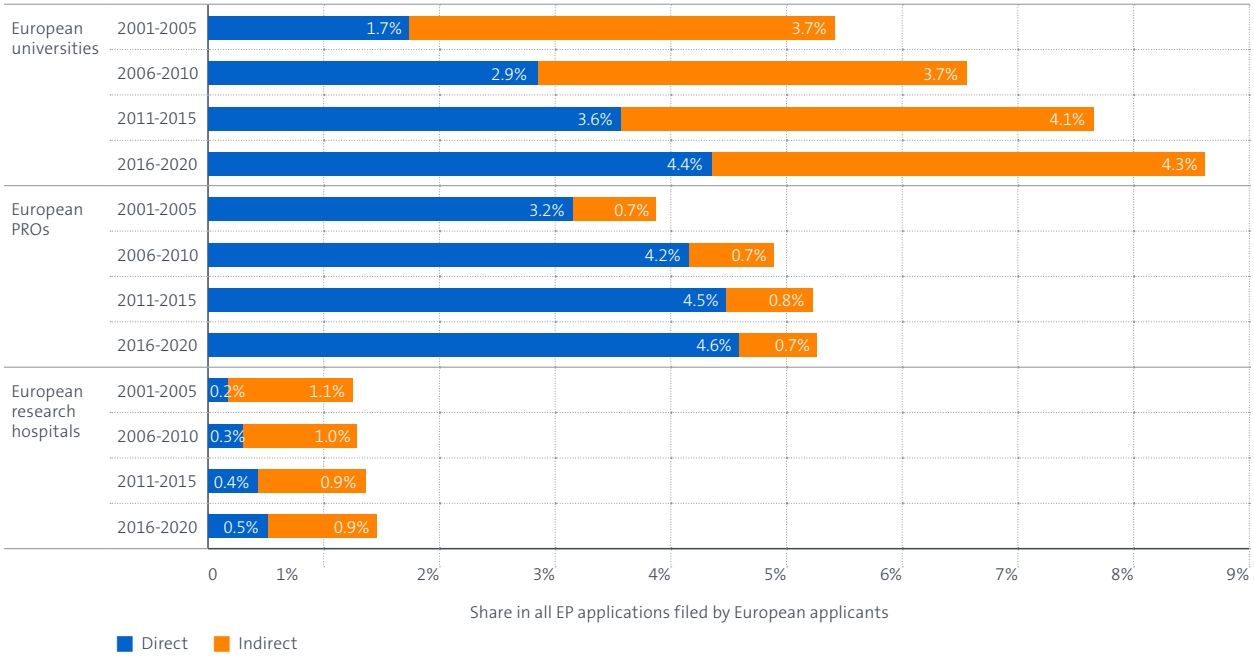
These data are also linked to governance and budget decisions by European governments. As shown in Figure 5, the majority of public investment in research is directed towards universities rather than other public institutions (European Commission, 2025). The shares of patenting likely reflects established traditions in R&D budget allocations.

5 For more information, see the report here: epo.org/university-innovation-study

6 Note that many European research hospitals are closely affiliated with or integrated into university systems – such as AP-HP (Assistance publique-Hôpitaux de Paris) with various Paris universities or Charité in Berlin with Humboldt University and Freie Universität Berlin.

Figure 28

Share of direct and indirect academic patents of European universities, PROs and research hospitals as percentage of EP applications from European applicants by five-year periods



Source: EPO - PATSTAT, Elsevier Scopus

4.2 Benchmarking technology specialisation of academic patents from European PROs and universities

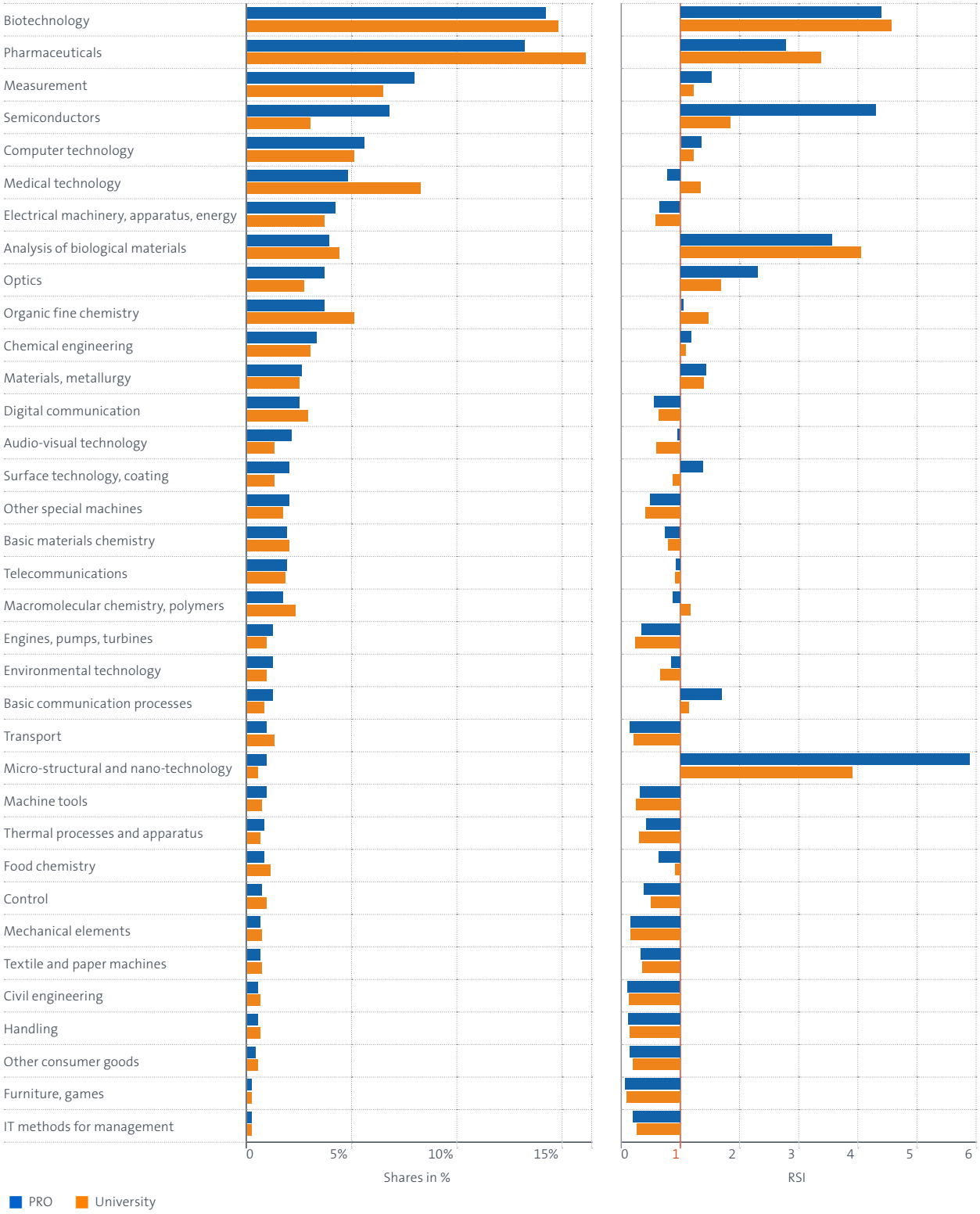
This section expends the technology analysis from PROs (see Chapter 1.3) to European universities. Both institution types show convergent specialisation in biotechnology, with nearly identical shares (14.3% PRO vs 14.9% universities) and identically high RSI values, indicating this field represents a fundamental strength across European academic research (Figure 29). Pharmaceuticals also constitute a major focus area for both, though universities show slightly higher share and concentration (16.2% vs 13.3%). Additional similarities emerge in computer technology (5.6% vs 5.1% shares), materials/metallurgy (2.6% vs 2.5%) and basic materials chemistry (1.9% vs 2.0%).

Significant divergences appear most notably in medical technology. Universities demonstrate clear specialisation (RSI 1.36, 8.3% share) while PROs fall below the specialisation threshold (RSI 0.8, 4.8% share). Semiconductors reveal the opposite pattern, with PROs showing very strong specialisation (RSI 4.3, 6.8% share) compared to universities' more moderate specialisation (RSI 1.9, 3.0% share).

PROs also maintain stronger positions in measurement technologies (RSI 1.5 vs 1.2), optics (RSI 2.3 vs 1.7), and micro-structural/nanotechnology (RSI 6.9 vs 3.9). Conversely, universities show stronger specialised focus in organic fine chemistry (RSI 1.5 vs 1.1) and macromolecular chemistry/polymers (RSI 1.2 vs 0.9). These patterns suggest PROs concentrate more heavily in advanced instrumentation and physical sciences, while universities maintain stronger positions in medical applications and certain chemical domains.

Figure 29

Distribution of PRO and university-related academic patents across technology fields and Relative Specialisation Index (RSI), 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

Figure 30 shows the evolution of specialisation patterns between the two periods 2011-2015 and 2016-2020 for European PROs and universities. Both PROs and universities achieved transformative specialisation in telecommunications, transitioning from non-specialised positions to clear specialisation above the 1.0 threshold. This represents a synchronised institutional response to digital transformation demands, suggesting both institution types recognised telecommunications as strategically important. Similarly, both institutions showed meaningful gains in medical technology, with universities progressing from moderate to strong specialisation while PROs moved closer towards the threshold, indicating convergent prioritisation of medical innovation. Biotechnology demonstrates parallel decline patterns for both institutions, though both retained strong specialisation levels despite reductions. This suggests sector-wide maturation.

Digital technologies reveal the most striking institutional divergence. While PROs achieved substantial specialisation gains in digital communication (moving towards specialisation), universities showed minimal movement in this domain. At the same time, universities achieved meaningful specialisation advancement in environmental technology, while PROs showed modest decline, indicating universities may have embraced sustainability research more actively than PROs.

Computer technology is another field with contrasting developments. PROs experienced significant erosion in its specialisation level, while universities maintained stronger positioning despite modest decline. Organic fine chemistry shows opposite trajectories: PROs maintained modest growth while universities experienced substantial decline, suggesting different priorities in chemical research domains and potentially reflecting PROs' closer industry collaboration in chemical applications.

PROs achieved significant specialisation enhancement in pharmaceuticals, building upon an already-strong specialised position to reach even higher levels of pharmaceutical focus. In contrast, universities showed minimal pharmaceutical advancement, maintaining their strong specialised position.

Figure 30

Change in specialisation (RSI) for university and PRO-related academic patents between 2011-2015 and 2016-2020

Source: EPO - PATSTAT, Elsevier Scopus

The patent quality indicators for 2001-2020 presented in Table 3 reveal distinct patterns across different types of academic institutions, offering insights into their varying approaches to innovation and technology transfer. While universities demonstrate the highest grant rate at 63.5%, PROs exhibit different characteristics with a 60.7% grant rate but with larger average family sizes (5.67 vs 5.42) and superior citation performance (5.15 average citations compared to 4.53 for universities). This suggests that PRO patents, while facing slightly higher rejection rates, tend to have broader international protection and greater technological impact. Research hospitals exhibit the most distinctive profile across all metrics, with notably large family sizes at 6.79 and the highest citation rates at 5.83, alongside 64.3% of academic patents receiving forward citations. This performance is partly attributable to research hospitals' extreme focus on inventions in the biotechnology and pharmaceutical sectors, which typically show broader geographical patent protection and generate higher citation rates due to their commercial significance. However, when controlling for sectoral effects through the weighted citation score the differences become more moderate, with research hospitals scoring 1.72 compared to PROs at 1.59 and universities at 1.46, indicating that sectoral concentration explains part but not all of the performance differential. PROs consistently position between universities and research hospitals across most quality measures, notably exceeding the overall EPC averages for both family size (5.67 vs 5.57) and citations (5.15 vs 4.71) while maintaining grant rates comparable to research hospitals.

Table 3

Qualitative benchmarking of academic patents

EP applications 2001-2020	Grant rate	Average family size	Av. number of forward citations	% with forward citations	Weighted citation score
All EPC member states	63.2%	5.58	4.71	60.2%	1.92
University	63.5%	5.42	4.53	59.0%	1.46
PRO	60.7%	5.67	5.15	62.2%	1.59
Research hospital	60.7%	6.79	5.83	64.3%	1.72

Source: EPO - PATSTAT, Elsevier Scopus

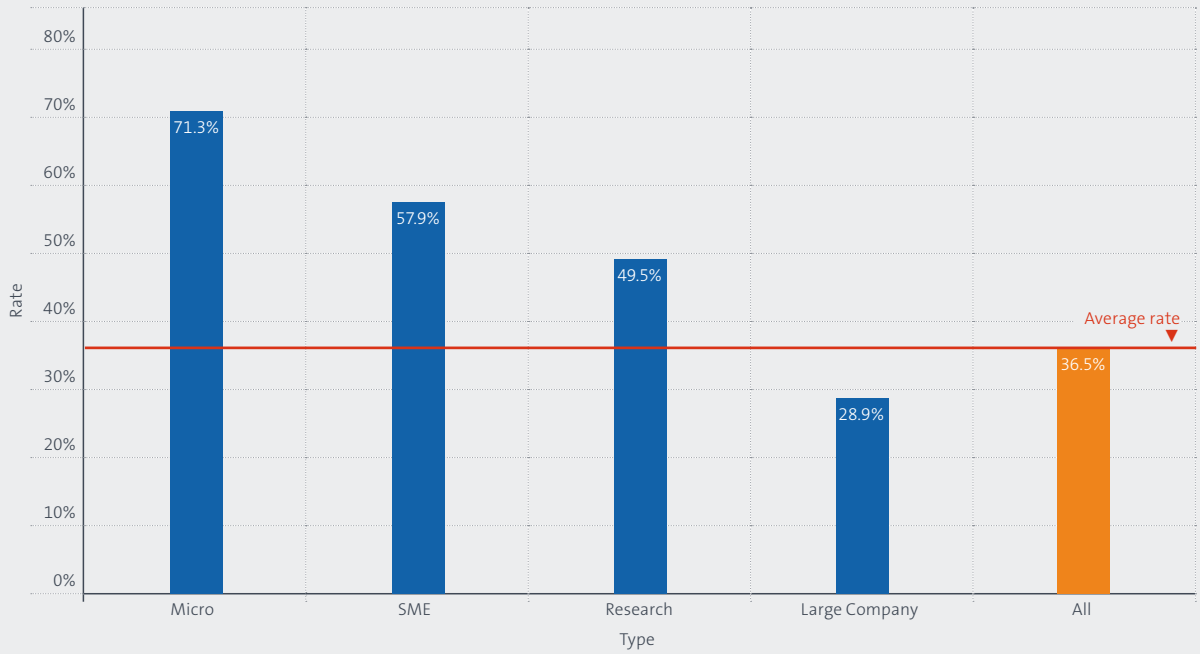
Box 6: The Unitary Patent – uptake by European research institutions

The European Patent with Unitary Effect (Unitary Patent) is a key development in European intellectual property law that became operational on 1 June 2023. The Unitary Patent is based on the existing European Patent Convention (EPC) system. The pre-grant examination process remains identical to traditional European patents, conducted by the European Patent Office (EPO). However, after grant, patent holders can request "unitary effect" within one month, converting their European patent into a single patent that provides uniform protection across currently 18 participating EU member states. The system eliminates expensive national validation procedures, translation requirements (after a transitional period) and multiple renewal fee systems. This represents significant savings compared to validating patents in multiple countries individually. Instead of managing patents separately in each country, applicants can deal with a single patent through the EPO as a "one-stop shop". This reduces administrative burden substantially. In addition, the Unified Patent Court (UPC) provides centralised litigation for patents with unitary effect, eliminating costly multi-jurisdictional disputes and ensuring consistent legal interpretation.

The analysis of patent grants at the EPO published in the first half of 2025 in Figure 31 reveals that the overall uptake rate among European applicants is high with 36.5%.[7] However, the data also reveals striking differences in Unitary Patent adoption across applicant categories. Micro companies demonstrate the highest uptake at 71.3%, nearly doubling the overall European average of 36.5%. Small and medium-sized enterprises (SMEs) follow with a robust 57.9% adoption rate, while research institutions show moderate engagement at 49.5%. In stark contrast, large companies exhibit the lowest uptake at just 28.8%.

Figure 31

Unitary Patent uptake rate by organisation type, January-June 2025



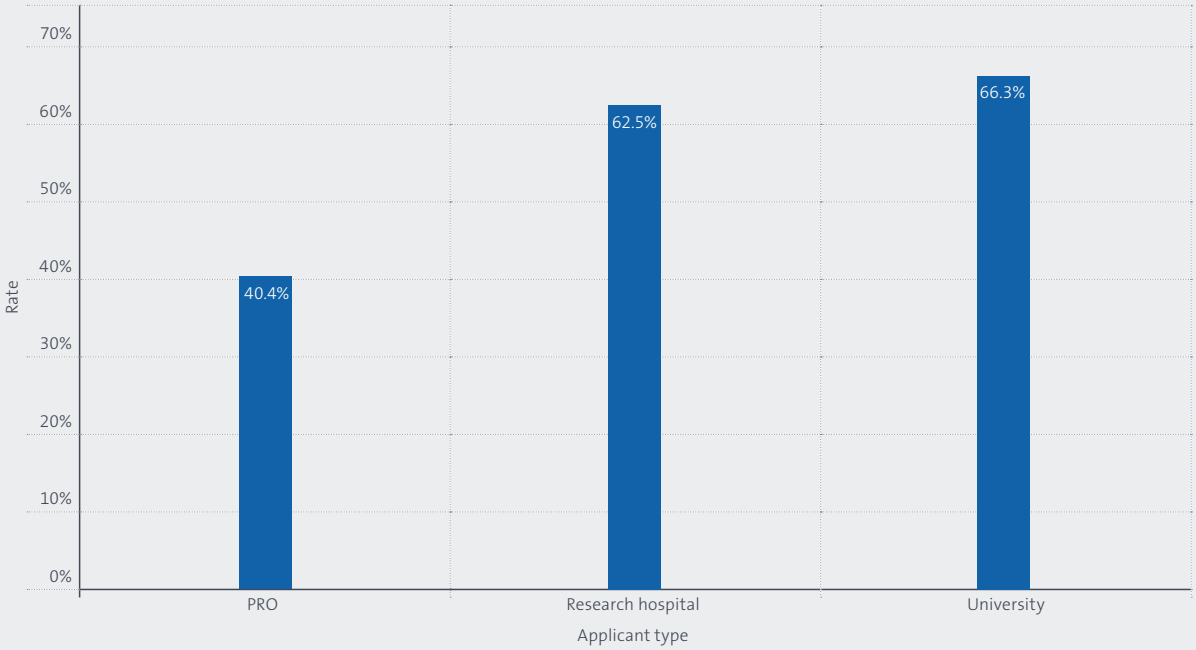
Source: EPO

7 The disambiguation was performed on the first applicant of the patent applications. Co-applicants were not considered, in line with the report in EPO's Patent Index.

The analysis of Unitary Patent adoption across research institution types in Figure 32 reveals significant institutional differences in strategic IP management approaches. Universities lead with the highest uptake rate at 66.3%, substantially exceeding both the research sector average (49.5%) and the overall European average (36.5%). Research hospitals follow with a solid 62.5% adoption rate, while PROs lag considerably at 40.4%.

Figure 32

Unitary Patent uptake rate by type or research institution, January-June 2025

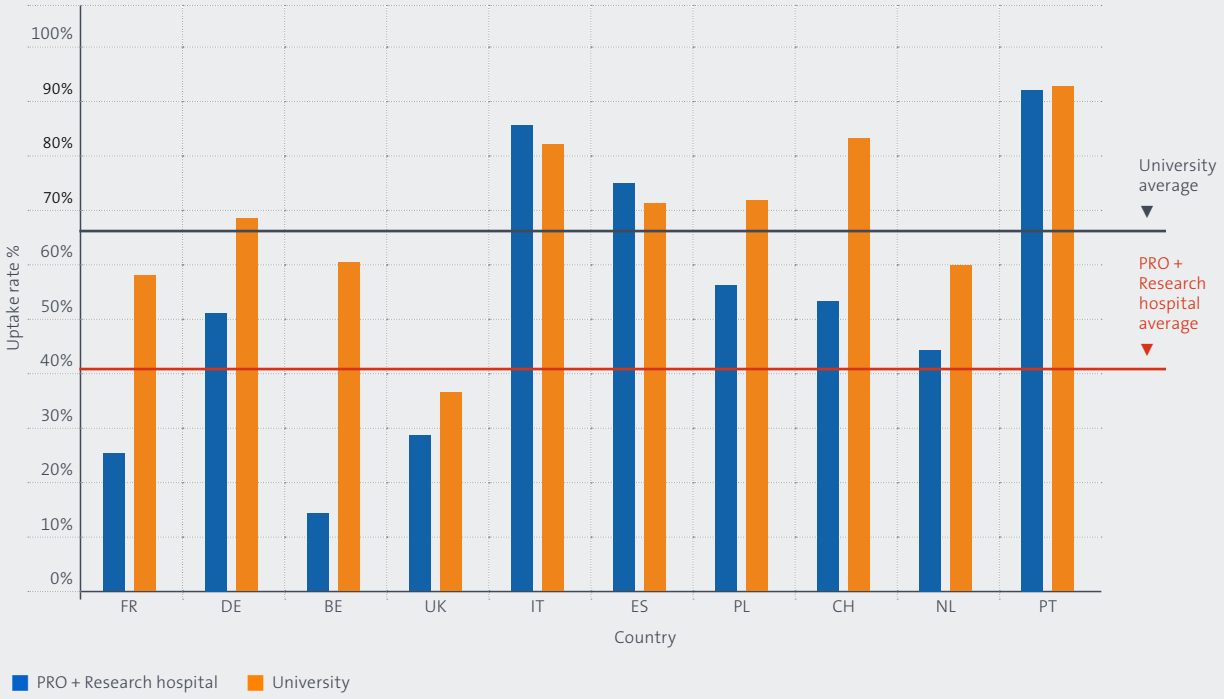


Source: EPO

Analysing Unitary Patent uptake among countries with the highest numbers of European Patent grants in Figure 33 reveals striking patterns tied to both applicant type and national context. Universities consistently outperform PRO+Research hospitals across virtually all countries. Universities demonstrate strong engagement with the UP system, with countries like Portugal (92.9%), (83.3%), Italy (82.2%), and Germany (68.6%) achieving uptake rates well above the European university average of 66.3%. Even in countries with lower rates – such as France (58.1%) or Belgium (60.5%) – universities still substantially outperform their national PRO+Research hospital counterparts. PRO+Research hospital show more variable and generally weaker engagement, with only three countries – Italy (85.7%), Portugal (92.3%), and Spain (75%) – exceeding what appears to be a European average of approximately 41%. Major research countries like France (25.3%) and Belgium (14.3%) show particularly weak adoption in this category.

Figure 33

Unitary Patent uptake rate by country and type or research organisation, January-June 2025



Source: EPO

Case study: Damae Medical

Headquarters	Paris, France
Founded	2014
No. of employees	30
Products	Non-invasive, advanced medical imaging in the dermatology field
Partner institution	Institut d'Optique Graduate School, Université Paris-Saclay and Centre National de la Recherche Scientifique (CNRS)
Full EPO innovation case study	https://link.epo.org/elearning/sme_case_study_damae_medical_en.pdf

Damae Medical is a French company that spun out in 2014 of the Laboratoire Charles Fabry (UMR8501), Mixed Research Unit affiliated with the Institut d'Optique Graduate School, the CNRS and the Université Paris-Saclay. For over a decade, the company has developed and refined imaging devices and AI-based solutions to support dermatologists in diagnosing skin conditions. With roots in photonics research, the company has steadily expanded its intellectual property portfolio while validating its technologies in clinical settings. Today, Damae's flagship solution is deployed in more than 40 centres across 12 countries, backed by validation from over 240 clinical studies.

Beyond the lab

To screen for skin cancer, dermatologists typically begin with a visual examination of the skin, followed by inspection with a dermoscope. If suspicious features are identified, a biopsy may then be performed and the tissue analysed in a laboratory. The limitation of this approach is that when no clear external signs are visible, a biopsy may not be requested and cancer may go undetected. Although skin cancer is among the most common forms of cancer, its early stages remain particularly challenging to diagnose.

It was against this backdrop that Professor Arnaud Dubois, a leading researcher in optical coherence tomography (OCT), joined forces with two of his graduate students. In 2013, as part of their final-year project in biophotonics, Anaïs Barut and David Siret were challenged to design a business proposition for a potential startup. Their search for a viable innovation led them to Dubois's work, and together they began exploring applications of OCT in the biomedical field. Convinced of the technology's market potential, Dubois filed a patent application at the end of 2013, paving the way for the creation of Damae Medical the following year.

Taking control of IP

The initial patent application, filed jointly by Institut d'Optique Graduate School, Université Paris-Saclay and the CNRS, became the cornerstone of the new venture. With the three institutions as co-owners, responsibility for commercialising the intellectual property was entrusted to CNRS Innovation, the Technology Transfer Office charged with identifying partners, negotiating exploitation contracts and ensuring effective management of the rights. Following negotiations, Damae Medical initially secured an exclusive licence to the core patent family in exchange for royalties on future sales. Supported by growing business success, Damae Medical later acquired outright ownership of the patent family in 2019 through a purchase agreement, finalised in return for equity.

Funding a growing business

Over the past decade, Damae has secured more than EUR 20 million in funding through a combination of seed and Series A rounds, supported by both venture capital and private investors. This financing has been complemented by public funding, including a EUR 2.4 million grant from the European Union's Horizon 2020 programme. A key factor in attracting investment was the strength of Damae's technology and intellectual property. During fundraising rounds, investors conducted detailed audits of the company's IP portfolio, reviewing patents, trademarks, know-how, domain names, and software and database copyrights. The favourable outcomes of these audits provided reassurance that Damae's innovations were well protected and its business model robust, giving investors the confidence to commit capital.

Building a robust product line

At the heart of Damae Medical's innovation is Line-field Confocal Optical Coherence Tomography (LC-OCT), an imaging technology that combines the depth of OCT with the high resolution of confocal microscopy. It enables real-time, non-invasive "digital optical biopsies" of the skin, capturing layers beneath the surface in great detail through vertical and horizontal sections at micrometre resolution, which can then be assembled into a precise 3D image.

The company's flagship device, deepLive™, translates this breakthrough into clinical practice. A CE-marked Class IIa medical device, deepLive integrates LC-OCT with proprietary software and AI tools to help dermatologists detect malignant tumours earlier, define tumour margins with precision and reduce unnecessary biopsies. Its development has been safeguarded by a robust IP strategy, with multiple patent families covering core LC-OCT inventions and enhancements, alongside trademarks protecting the LC-OCT and deepLive brands.

Foundational support for entrepreneurs

CNRS Innovation, founded in 1992, is a public limited company majority-owned by the CNRS (90%) and Bpifrance Financement (10%). Its mission is to facilitate the transfer of innovative technologies originating from CNRS Mixed Research Unit into industry.
CNRS Innovation supports projects from their inception to the granting of exploitation rights, offering services such as intellectual property strategy consulting, participation in patent filings, identification and engagement of industrial partners, negotiation and drafting of licensing agreements, and management of patent portfolios. Backed by a team of 70 experts, it has signed 1 487 operating contracts since 2012, supported 256 pre-maturity projects since 2014, assisted 94 start-ups through its RISE programme since 2019, and manages a portfolio of 1 100 patent families.

5. Impact of research institutions on the European innovation ecosystem

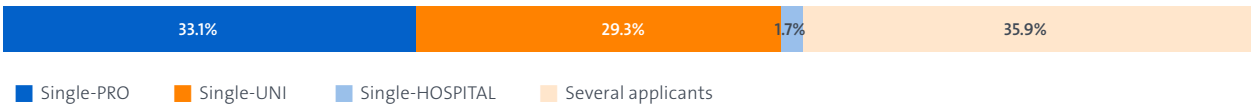
This chapter examines how European research institutions contribute to the innovation ecosystem through two key mechanisms: collaborative research networks and startup creation. The analysis uses patent co-applicant data to map collaboration patterns among universities, public research organisations and research hospitals, exploring their partnerships with each other and with industry partners across different geographical scales. Additionally, the chapter profiles European startups, identified through the Dealroom database, that serve as patent applicants or co-applicants alongside academic institutions, providing insights into how research institutions foster entrepreneurial ecosystems and facilitate the commercialisation of academic innovations.

5.1 Collaboration networks

This analysis examines the collaboration networks of European research institutions through co-applicant patterns in direct academic patents filed between 2016-2020, where at least one applicant is a European research institution (university, PRO or research hospital). The findings reveal distinct collaboration strategies across institutional types: 64.1% of the direct academic patents involve single institutional applicants, with European PROs acting as sole applicants in 33.1% of all cases, universities in 29.3% and research hospitals in 1.7% (Figure 34). However, 35.9% of direct academic patents involve multiple co-applicants – a substantially higher rate compared to general European patent applications. This elevated co-application rate indicates that European research institutions actively engage in multi-institutional partnerships, suggesting strong networks for knowledge sharing and technology development.

Figure 34

Distribution of European direct academic patents by applicant structure across eight leading countries, 2016-2020

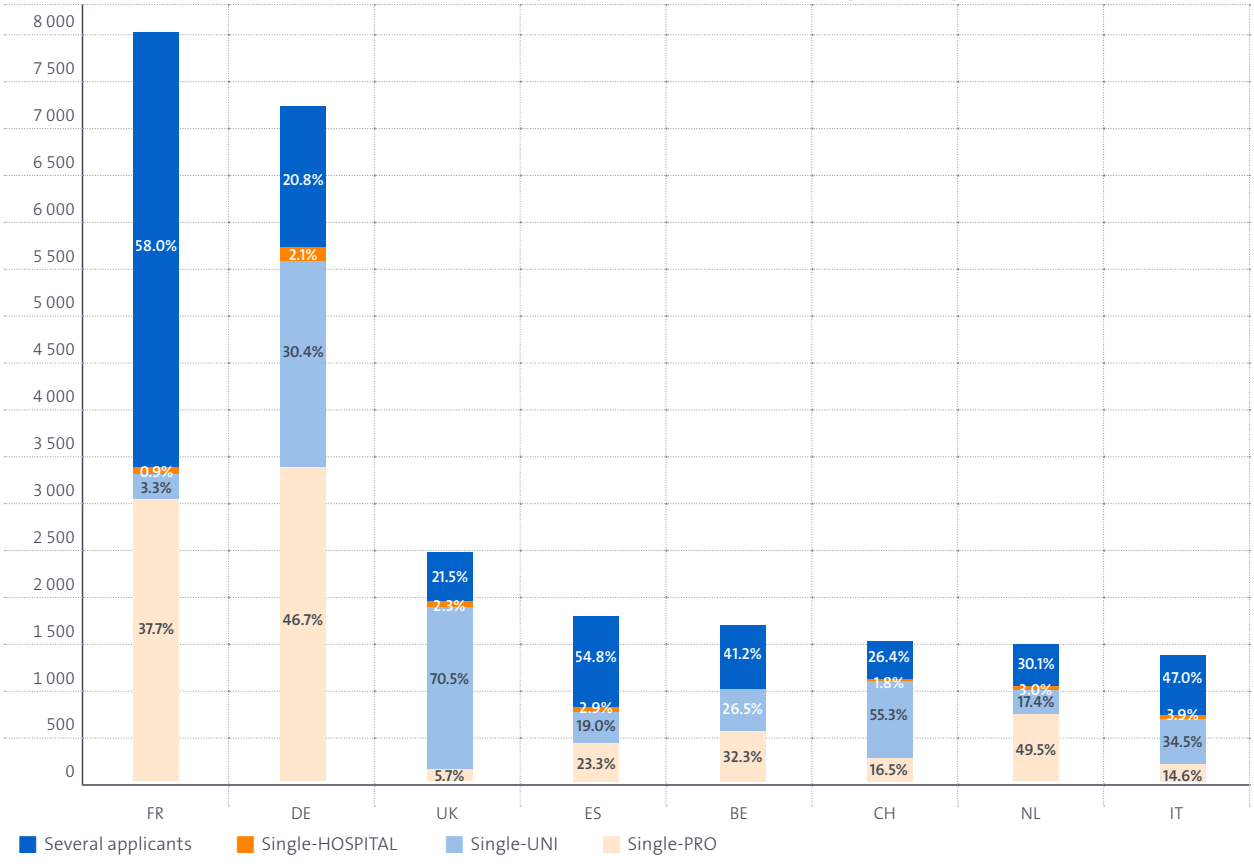


Source: EPO - PATSTAT, Elsevier Scopus

Looking at the country-specific patterns across the eight European countries with the highest direct academic patent volumes in Figure 35, distinct applicant structures emerge that reflect both collaboration patterns and national patenting policies. France and Spain demonstrate by far the highest rates of multi-applicant patents with "several applicants" accounting for 58% and 54.8% respectively of their direct academic patents, while Germany and the UK show the lowest multi-applicant rates at 20.8% and 21.5%. France's exceptionally high rate likely reflects national practices of listing multiple institutions as co-applicants, often a combination of universities and PROs. The United Kingdom and Switzerland show a predominantly university-centric pattern with single university applicants representing over 50% of their direct academic patents and relatively low multi-applicant rates (21.5% and 26.4%). Italy and Belgium demonstrate more moderate multi-applicant rates ranging from 41-47%, while the Netherlands show the highest rate single PRO filings at almost 49.5%.

Figure 35

Distribution of European direct academic patents by applicant structure across eight leading countries, 2016-2020



Source: EPO - PATSTAT, Elsevier Scopus

The analysis in Figure 36 further looks at who the collaboration partners are, focusing on the different types of applicants and disregarding co-applications among same research institution types, such as university-university, PRO-PRO, or co-applications among research hospitals. The focus is therefore on co-application patterns across different types of research entities, especially between research institutions and industry partners, such as small and medium-sized enterprises (SMEs, as defined by EU Recommendation 2003/361/EC) and large enterprises.

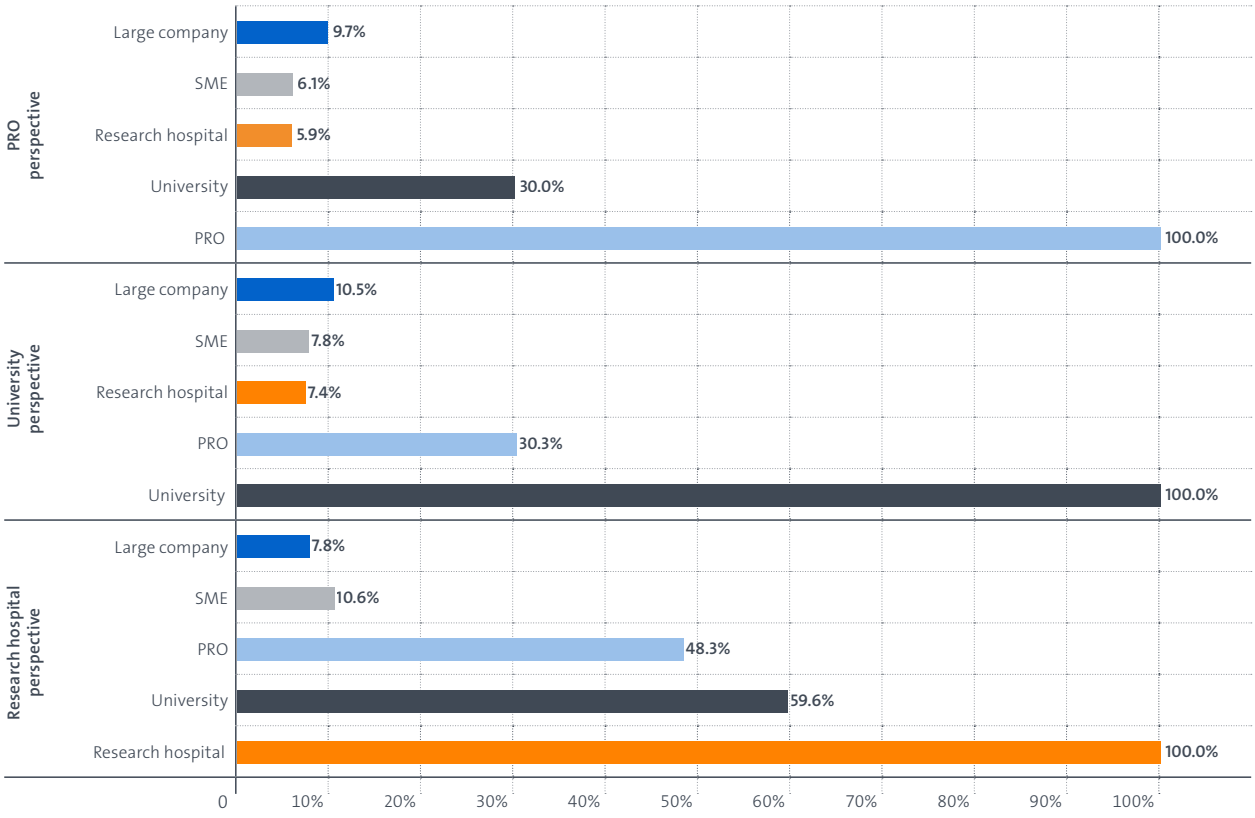
The analysis of co-applicant patterns from each European research institution perspective reveals distinct partnership structures that serve as indicators of underlying collaboration networks. Universities and PROs exhibit remarkably similar co-application patterns: approximately 30% of their respective direct academic patents involve co-applications with each other (PROs: 30% co-applied with universities: universities: 30.3% co-applied with PROs), suggesting strong bilateral research partnerships between these institutional types. Both also demonstrate comparable patterns of industry engagement, appearing as co-applicants with large companies in around 10% of EP applications (PROs: 9.7%; universities: 10.5%) and with SMEs in 6.1% for PROs and 7.8% for universities.[8]

Research hospitals display distinctly different co-application profiles, showing significantly higher integration with other research institutions in their patent portfolios. Nearly 60% of research hospital patents involve university co-applicants and 48.3% include PRO co-applicants, indicating that research hospitals may function more as collaborative nodes within academic networks rather than independent patent applicants. Notably, research hospitals demonstrate higher rates of co-application with SMEs than large companies (10.6% vs 7.8%), contrasting with the patterns observed for universities and PROs and potentially reflecting differences in technology transfer approaches or the nature of medical innovations that may align better with specialised SME capabilities.

8 Multi-party co-applications involving combinations of research institutions, large companies and SMEs remain rare across all institutional perspectives.

Figure 36

Co-applicant patterns in European direct academic patents by institutional perspective, 2016-2020



Source: EPO - PATSTAT, Elsevier Scopus

Co-applicant origins of direct academic patents filed between 2016 and 2020 reveal a pronounced national focus: 79.3% of collaborative filings involve entities from the same country, underscoring the enduring dominance of domestic research networks (Figure 37). Cross-border partnerships within only European applicants account for 9.9% of co-applied patent applications, reflecting modest but meaningful intra-European integration of academic and research institutions. Collaborations with institutions outside Europe, mostly from the US, comprise 10.8%. While this overall pattern holds for direct academic patents from all three research institution types, universities exhibit a slightly higher propensity to form both exclusive inter-European and extra-European partnerships compared to PROs and research hospitals, suggesting that universities may be more agile in pursuing global and regional collaborations.

Figure 37

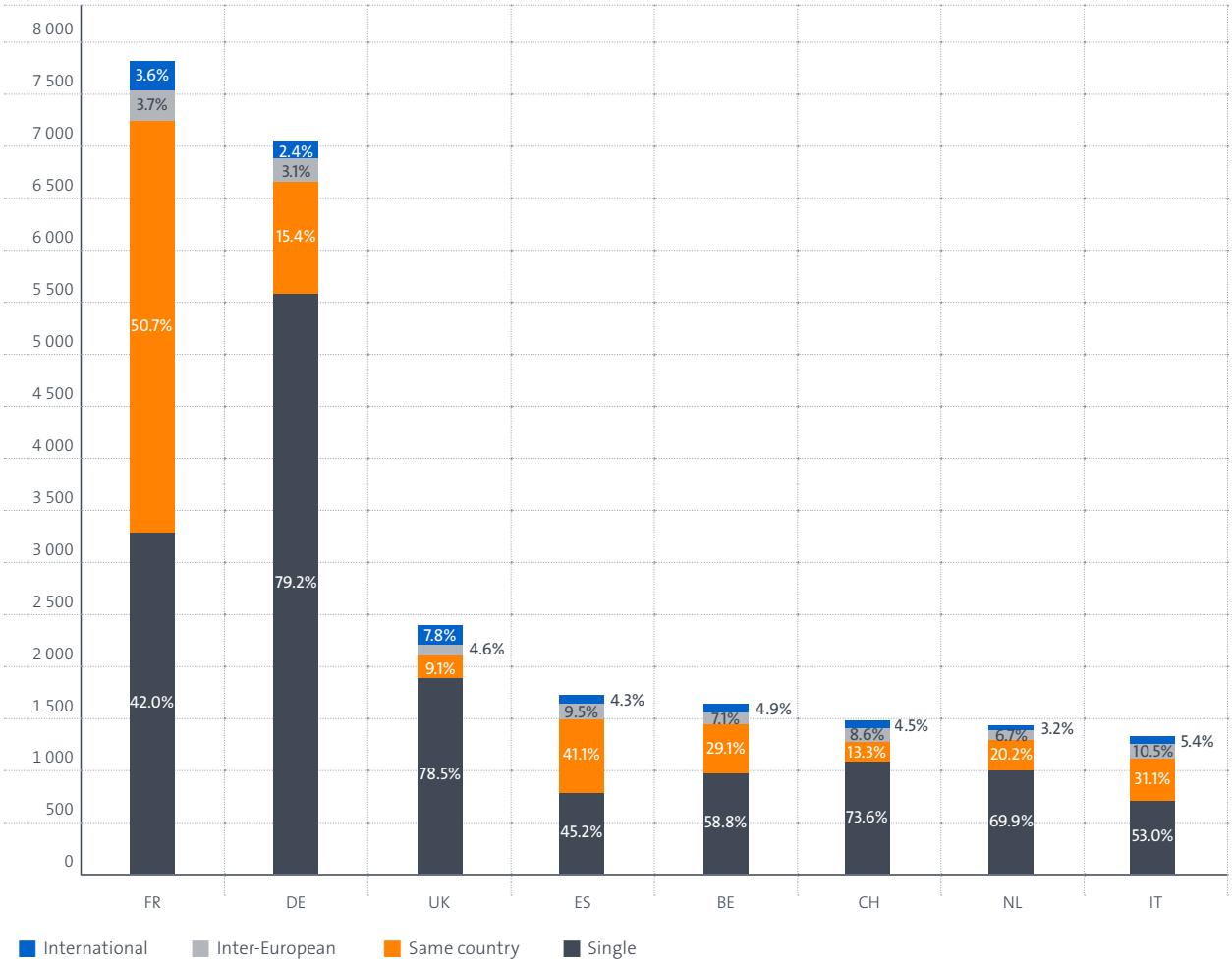
Distribution of co-applied European direct academic patents by origin of co-applicants, 2016-2020

Source: EPO - PATSTAT, Elsevier Scopus

Among patents with multiple applicants, significant cross-country variations emerge in collaboration geography as displayed in Figure 38. France shows that among its collaborative patents, same-country partnerships dominate. More than every second academic patent has several French research institutions as applicants, while inter-European (3.7% of total) and international (3.6% of total) collaborations represent much smaller shares. This means that when French institutions co-apply for patent protection, they predominantly work with other French research entities. Germany shows a markedly different pattern, with domestic co-applications comprising 15.4% of total direct academic patents and more modest cross-border engagement through inter-European (3.1%) and international (2.4%) collaborations. The lower overall collaboration rates may reflect different institutional practices or research organisation structures when it comes to distributing the ownership right to patent applications. Spain exhibits more internationally oriented collaboration with same-country shares close to France at 41.1% but complemented by substantial cross-border engagement through 9.5% exclusively inter-European and 4.3% international collaborations, indicating a more geographically diverse partnership strategy. The United Kingdom presents a distinctive co-application profile with relatively balanced domestic (9.1%) and cross-border relationships, showing stronger international reach (7.8%) than inter-European collaboration (4.6%). Italy demonstrates particularly strong regional integration with 10.5% inter-European collaborations – among the highest rates observed – alongside 5.4% international partnerships.

Figure 38

Distribution of indirect academic EP applications by country and co-application type (single applicant, same country co-applicants, inter-European co-applicants, international co-applicants) for the eight leading European countries, 2016-2020



Source: EPO - PATSTAT, Elsevier Scopus

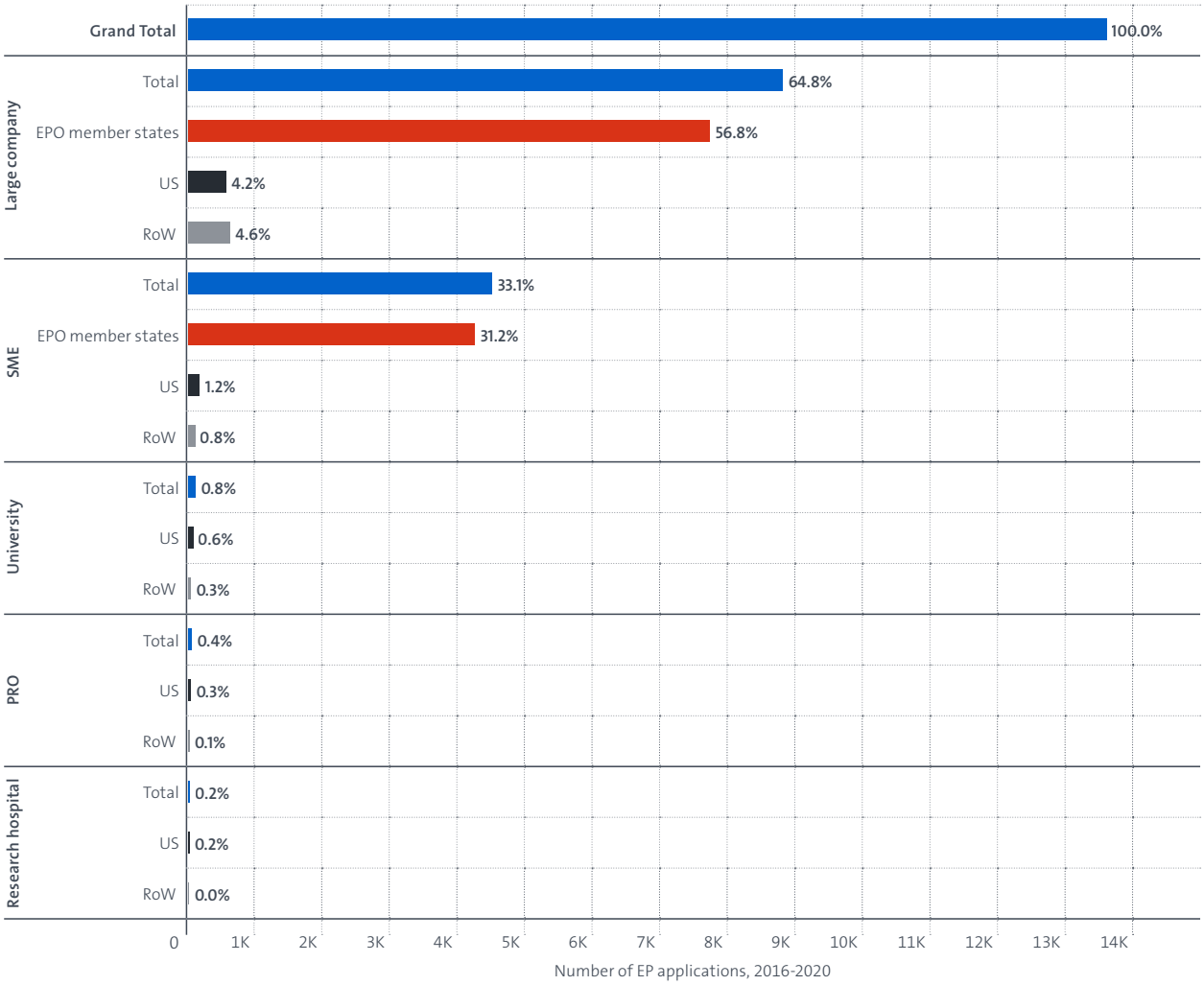
Over 13 000 indirect academic patents have been filed at the EPO between 2016 and 2020, with identified contributions by inventors affiliated with European research organisations. As shown in Figure 39, two-thirds of these EP applications have a large company (64.8%) as sole or co-applicant while over 33.1% involve SMEs. In rare cases, at least one applicant is a non-European research institution: universities (0.8%), PROs (0.4%) and research hospitals (0.2%).

Geographic patterns reveal European dominance with significant non-European participation: most applicants for European indirect academic patents are European companies. In almost 95% of indirect academic patents applied by SMEs, the SME is based in Europe and in almost 88% of cases where the applicant is a large company, it is headquartered in Europe. However, there is also significant involvement of non-European entities: 4.2% of all European indirect academic patents have a large US company as applicant and 1.2% a US SME. Additionally, 4.6% involve large companies from other non-European countries, mostly from Japan or China, and 0.8% involve non-European SMEs.

US entities demonstrate selective but meaningful engagement: while US participation is concentrated among large corporations rather than SMEs, this represents substantial American corporate interest in leveraging European research outputs. In cases where foreign applicants are non-European research institutions, they are predominantly US-based, indicating transatlantic research collaborations.

Figure 39

Geographic distribution of applicants in European indirect academic patents by entity type and country of origin, 2016-2020



Source: EPO - PATSTAT, Elsevier Scopus

Box 7: EARTO

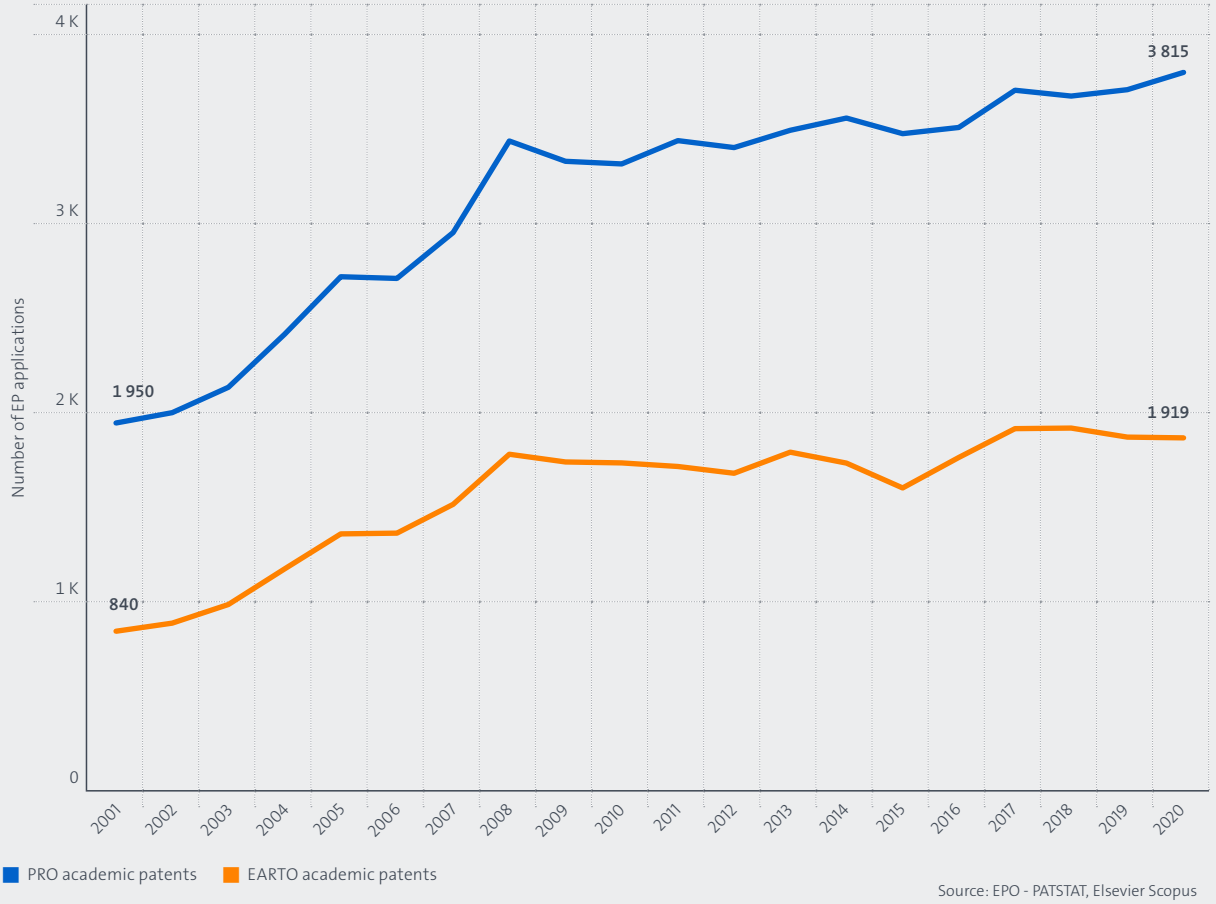
The European Association of Research and Technology Organisations (EARTO) is a Brussels-based association of European Research and Technology Organisations (RTOs), representing their interests in Europe. RTOs are included in this report under PROs and are non-profit organisations whose core mission is to produce, combine and bridge various types of knowledge, skills and infrastructures to deliver a range of research and development activities in collaboration with public and industrial partners of all sizes. The EARTO network counts over 350 RTOs in more than 32 mostly European countries, with over 228 000 highly skilled researchers and engineers managing a wide range of technology infrastructures.

RTOs are pivotal in bridging the gap between fundamental research and market-ready innovation. They play a vital role in spreading knowledge and driving patenting across Europe, turning public RD&I investments into concrete economic value and societal impact. Including major PROs such as the Fraunhofer Society in Germany and TNO in the Netherlands, as well as regional and specialised centres like the FEDIT network in Spain and the Łukasiewicz Research Network in Poland, EARTO members account for approximately half of public research outcomes representing nearly half of all PRO-related academic patent at the EPO (as shown in figure 40).

As shown in Figure 40, EARTO members (orange line) have consistently followed a trend that closely mirrors the overall patenting activity of PROs (blue line) over the past two decades.

Figure 40

All PRO-related academic patents vs academic patents by EARTO members, 2001-2020



Source: EPO - PATSTAT, Elsevier Scopus

RTOs' vital support for patenting and technology transfer

EARTO members play a central role in Europe's innovation landscape through their technology transfer offices (TTOs) and their own ventures, which help researchers transform scientific discoveries into viable business ventures. This role includes:

- Facilitating team formation and securing early-stage funding.
- Navigating complex regulatory environments.
- Providing intellectual property (IP) management models and open collaboration spaces.

EARTO members also deliver training on patenting strategies, guidance on IP management and access to legal expertise. Shared requirements and best practices across the network help members develop robust innovation strategies. With a strong focus on patent protection its members are frequently recognised among the world's top innovators.

RTOs as catalysts for deep-tech startup creation

RTOs are at the forefront of startup creation and spinoffs. They provide incubators, accelerators, and tailored support mechanisms that allow entrepreneurial initiatives to flourish. Through European cross-border collaborative projects, through instruments like public-private partnerships (PPPs), RTOs ensure that startups and SMEs can benefit from those partnerships, access to networks, and shared infrastructures.

This collaborative approach enhances Europe's capacity to generate high-growth companies and promote industrial renewal, and digitalization, while reinforcing European sovereignty in key technological domains.

RTO-driven research often delivers sustainable, market-ready innovations that align with EU climate goals and circular economy principles. An October 2024 EARTO study analyzing 15 RTOs created 393 deep-tech spin-offs, with survival rates above 80% after five years, reflecting both resilience and growth potential of these companies.

5.2 European startup ecosystem

Startups represent a critical pathway for transforming academic research into commercial applications, serving as intermediaries between university laboratories and the market. Through systematic analysis using the Dealroom database, 2 804 European startups that function as applicants or co-applicants for published academic patents filed at the EPO since 2000 have been identified. This identification methodology focuses specifically on startups that demonstrate direct involvement in the patent application process, either independently or in collaboration with academic institutions and excludes companies that solely license academic patents, research institution spin-offs without patent applications and ventures where academic inventors may not have maintained active scientific publications with their institutions' affiliation. As with all data relative to academic patents in this report, only European patent applications are considered.

Box 8: Deep Tech Finder

The startups in this sample are listed in the Deep Tech Finder – a free, interactive tool from the EPO Observatory on Patents and Technology designed to help investors, corporates, researchers and policymakers identify and connect with Europe's most innovative early-stage companies. The platform integrates EPO patent data with commercial information, offering a unique view of startups, universities and PROs that have filed European patent applications.

The Deep Tech Finder currently profiles over 10 000 European startups across technology fields, from quantum technologies and offshore wind to cancer diagnostics and artificial intelligence. Users can filter by technology domain, location, and investment stage, and access links to company websites and investor information.

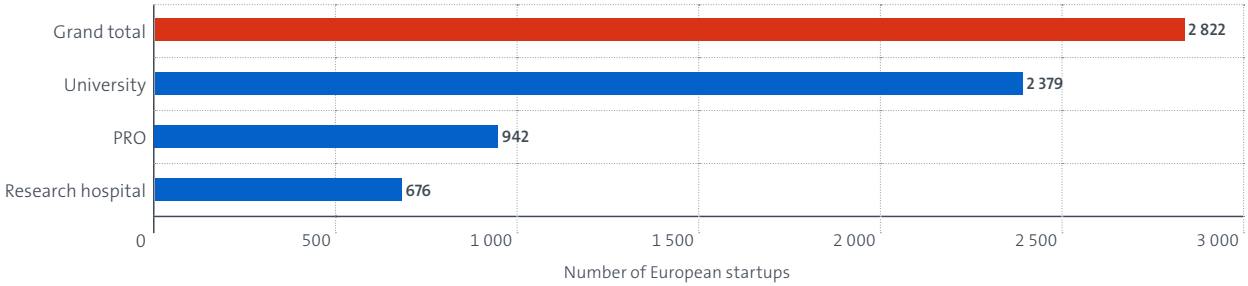
The tool is free to use, available online and as a mobile app, making it easy to search for promising deep tech companies. Access it at epo.org/deep-tech-finder.

The 2 822 European startups are associated with 8 730 academic patents and their geographic distribution, institutional partnerships, sectoral focus and growth stage characteristics offer insights into how European academic institutions engage with entrepreneurial ecosystems to advance research commercialisation.

The majority of startups, with 2 379 distinct European startup-institution relationships (84.3%), have ties to universities (Figure 41). PROs and research hospitals account for 942 (33.4%) and 676 (24%) affiliations respectively, underscoring the predominance of universities in patent-driven technology transfer through startups.

Figure 41

European startups with European patent applications on academic inventions and their affiliation with different types of European research institutions

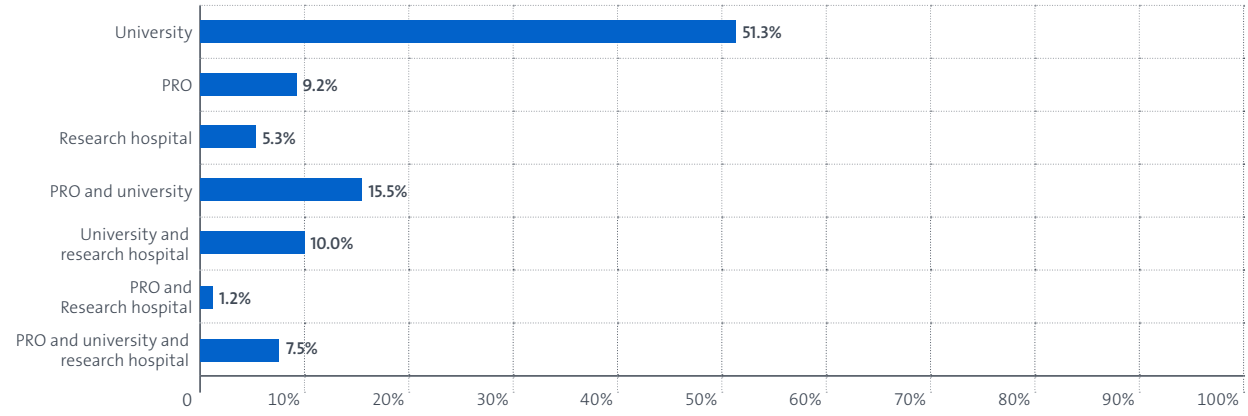


Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

Analysis of overlaps reveals that 34.2% of European startups have ties with more than one institution type through their European patent applications. Dual partnerships between PROs and universities are the most common, involving 15.5% of startups, while university-research hospital combinations occur in 10% of cases (Figure 42). PRO-research hospital links are relatively rare (1.2%), and 7.5% of startups are related simultaneously with all three institution types. These patterns indicate that multi-institutional engagement plays a substantial role in the patenting activities of European startups. This pattern reflects established institutional relationships within the European research ecosystem, where PROs and universities frequently collaborate due to complementary research capabilities and overlapping personnel networks. Many researchers maintain dual affiliations or move between these institution types throughout their careers, creating natural pathways for joint patent applications. Additionally, research hospitals often function as affiliated entities within university systems, while PROs typically maintain formal partnerships with universities for both fundamental and applied research projects.

Figure 42

Distribution of European startups by research institution relationship patterns

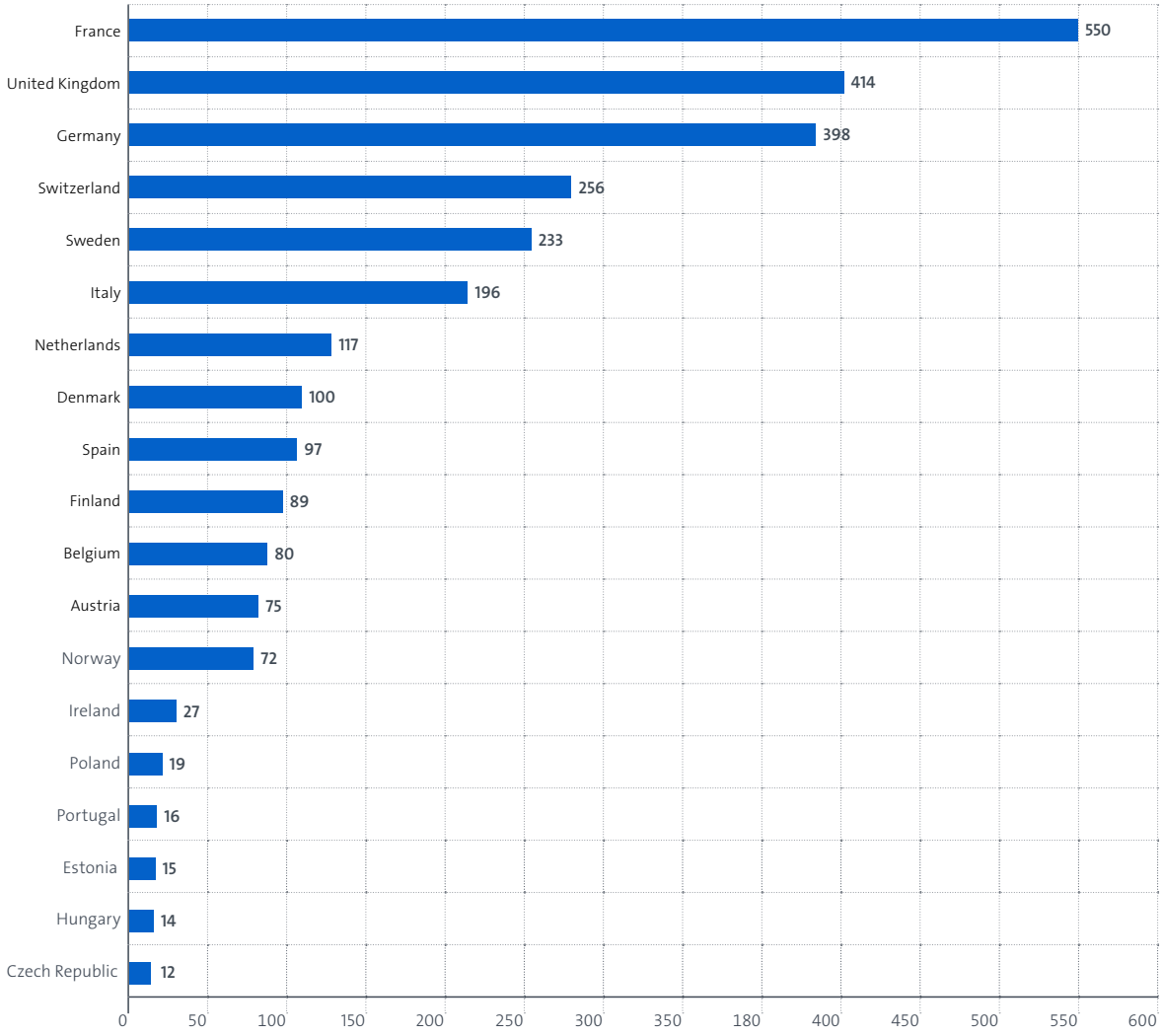


Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

Academic patent-filing startups are most heavily concentrated in France (550 startups), the United Kingdom (414) and Germany (398), with Switzerland (256), Sweden (233) and Italy (196) also comprising significant numbers (Figure 43). Figure 44 shows the distribution of the links between the startups and the different types of research distribution for these six countries. France demonstrates the most diverse multi-institutional collaboration profile, with only 19.5% of its startups linked exclusively to universities, while almost 35% indicate PRO-university partnerships and 19.8% involve all three institution types simultaneously. In contrast, the United Kingdom and Italy exhibit more university-centric patterns, with 72% and 75% of their startups respectively having ties solely to universities. Sweden stands out for its particularly strong university-research hospital connections (24.9%), reflecting the integration of medical research within its innovation framework. Germany and Switzerland occupy intermediate positions, with moderate levels of institutional diversity – Germany showing 52.5% university-only ties and notable PRO involvement (16.8%), while Switzerland demonstrates balanced engagement across institution types with 56.3% university-only relationships and substantial university-research hospital partnerships (14.8%).

Figure 43

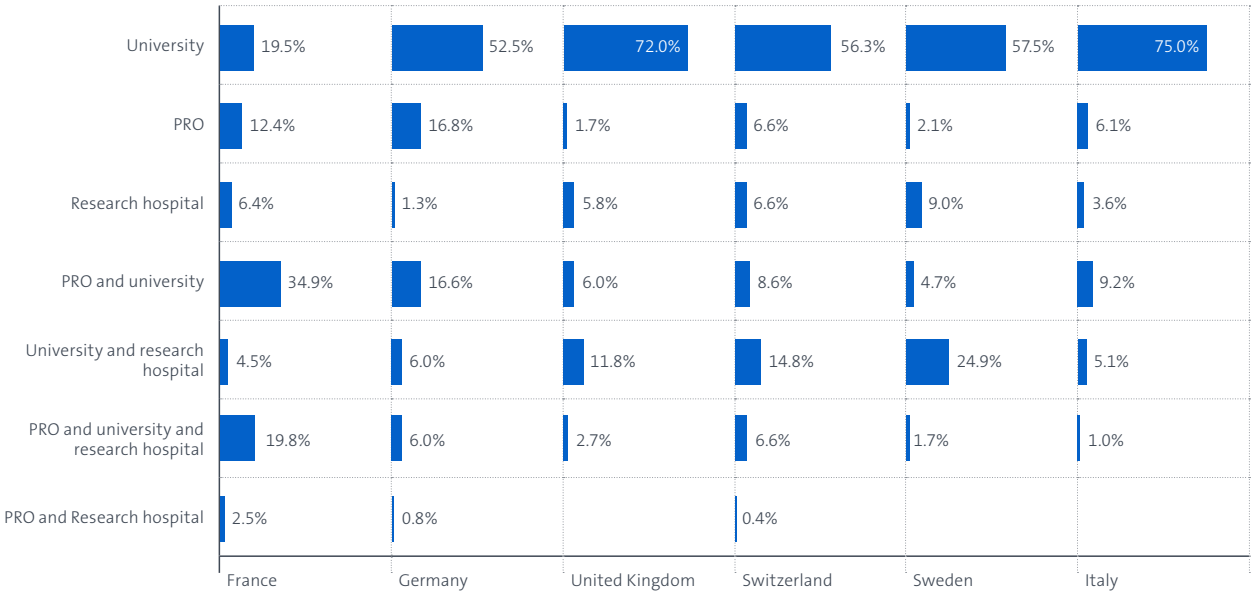
Distribution of European startups with EP applications with links to research institutions by country of origin of startup for countries with at least 10 startups



Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

Figure 44

Distribution of European startups by research institution relationship patterns for top six European countries



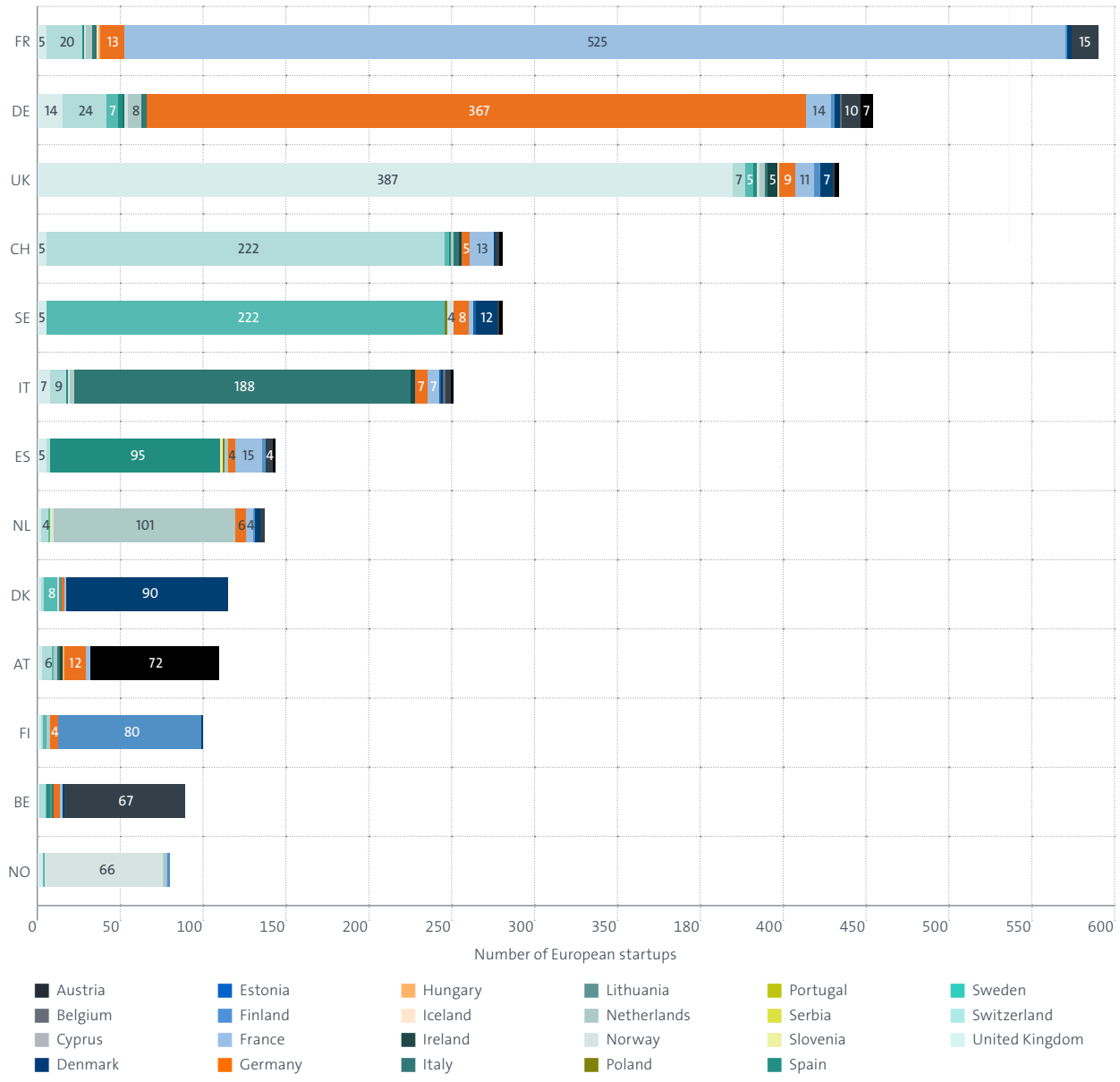
Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

Figure 45 shows the extent to which European research institutions contribute to startup patent activity both domestically and across borders. French research institutions demonstrate the strongest international reach, being linked to 591 startups in total, of which 525 are domestic French startups while 64 are based in other European countries – notably 20 in Switzerland, 15 in Belgium and 13 in Germany. UK research institutions contribute to 446 startups, with 387 being British ventures and 59 located elsewhere, including 11 in France, 9 in Germany and 7 each in Switzerland and Denmark. German research institutions are connected to 465 startups in total, supporting 367 domestic ventures and 98 international startups, with Switzerland (24), France (14) and the UK (14) being the primary beneficiaries. This pattern of cross-border knowledge transfer extends throughout Europe, with Swiss institutions supporting 259 startups (222 domestic), Swedish institutions contributing to 259 startups (222 domestic) and Italian institutions linked to 231 startups (188 domestic).

The analysis reveals 537 cross-border relationships between startups and research institutions from other European countries, compared to 2 611 domestic relationships. While the vast majority (82.9%) of European startup-research institution collaborations occur within national borders, the substantial cross-border activity demonstrates that European research institutions function as both national innovation assets and contributors to transnational entrepreneurial ecosystems. However, significant opportunities remain for expanding cross-border interaction, as current transnational relationships represent only 17.1% of all European startup-research institution collaborations, suggesting untapped potential for leveraging complementary research capabilities across European innovation ecosystems.

Figure 45

Cross-border partnerships: Distribution of European startups by country of research institution (vertical) and country of their linked startups (horizontal) for countries with at least 50 startups



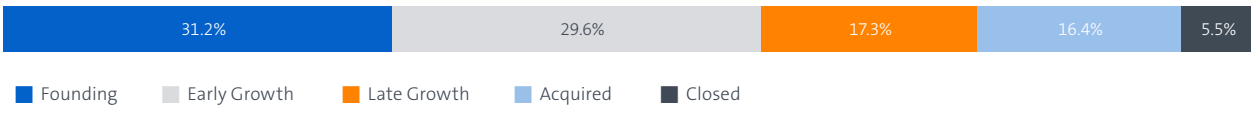
Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

The analysis of the profiles of European startups relying on academic patents reveals a dynamic ecosystem: according to Figure 46 only 5.5% of these ventures have closed, 16.4% have been acquired, 17.3% have reached late growth stage and roughly 30% remain in early growth or founding phases. Industry-wise (Figure 47), more than half operate in Healthtech (55.1%), followed by Energy (8.6%), Information Technology (8.2%) and Computer Hardware (7.1%).[9] Startups affiliated with research hospitals are overwhelmingly concentrated in Healthtech (86.4%), whereas those linked to PROs exhibit a comparatively larger share in Computer Hardware, and university-connected ventures show higher proportions in Information Technology, Robotics and Agrifood.

9 Dealroom industry descriptions available at: https://knowledge.dealroom.co/knowledge/industries-and-sub-industries?_ga=2.114437188.2125106324.1755004021-732263279.1727173180

Figure 46

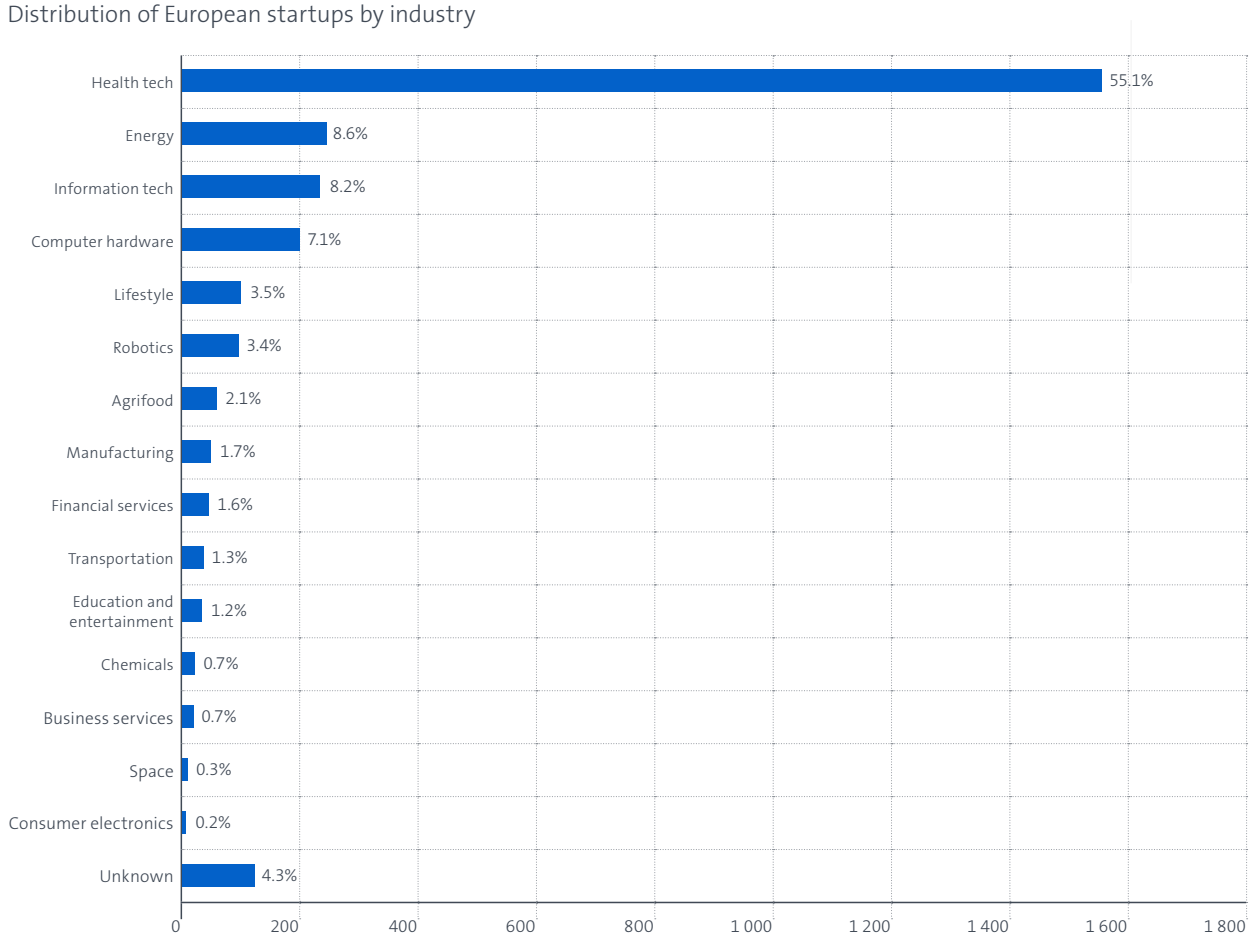
Distribution of European startups by growth stage



Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

Figure 47

Distribution of European startups by industry

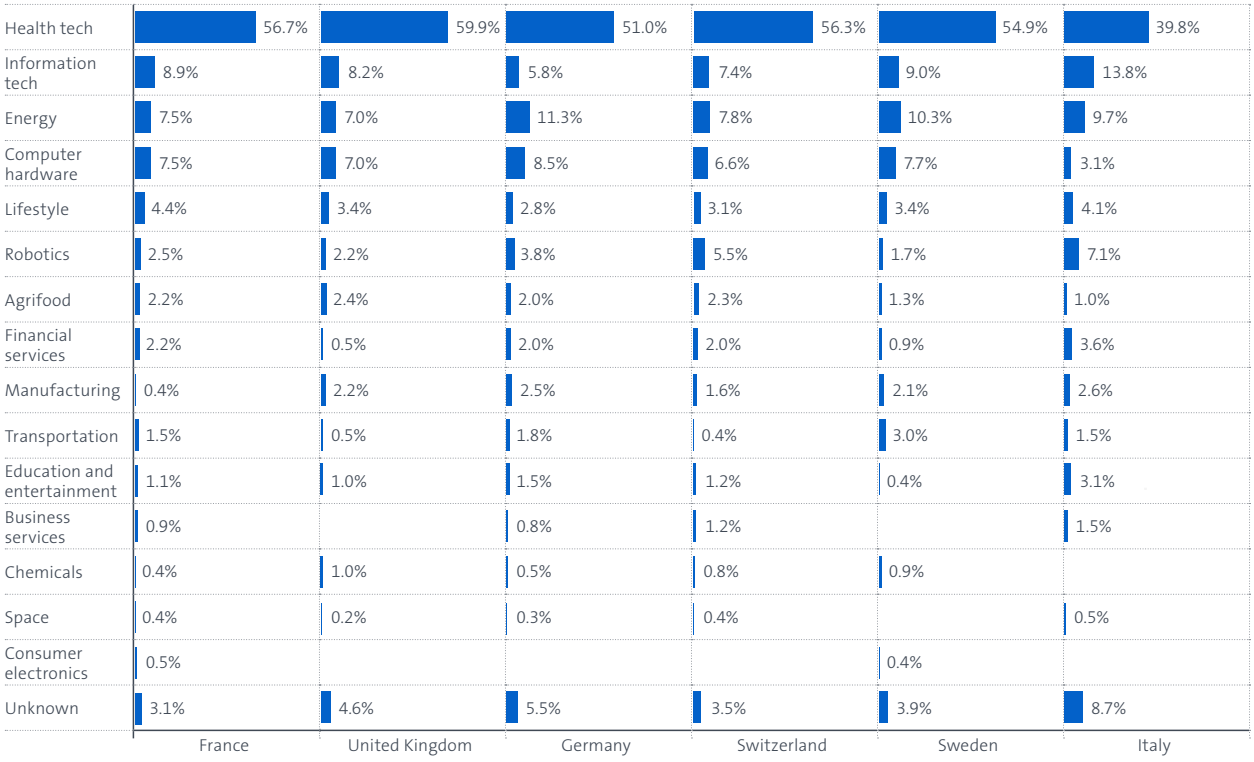


Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

The industry breakdown across Europe's six leading startup countries in Figure 48 highlights both commonalities and national distinctions. Healthtech is the dominant sector everywhere, ranging from 39.8% of startups in Italy to almost 60% in the United Kingdom. Energy and Information Technology follow as the next most prevalent sectors, with Germany and Sweden showing higher Energy concentrations (11.3% and 10.3% respectively) and Italy exhibiting stronger IT presence (13.8%). Robotics peaks in Switzerland (5.5%) and Italy (7.1%).

Figure 48

Distribution of European startups by industry for six European countries



Source: EPO - PATSTAT, Elsevier Scopus

The Deep Tech Finder contains commercial information from Dealroom, including number of funding rounds, total funding received, number of successful exits and changes in employment. Although the data coverage varies across companies, it enables assessment of the relative contributions of the 2 822 startups that rely on academic inventions from European research institutions (RESEARCH-based DTF startups) compared to those without clear patenting links to European research institutions. The indicators are based on reported data in the period 2021-2024 and are defined in the following way:

— Number of deals: The total count of all distinct funding rounds (both with and without a disclosed funding amount) for DTF companies within the time period 2021-2024. Data stems from 3 622 companies.

— Total funding: The total sum of capital raised in euros from all known funding rounds by DTF companies within the time period 2021-2024. Data stems from 2 713 companies.

— Net jobs created: The sum of the net change in employee headcount for all DTF companies within the time period 2021-2024, based on available employee chart data. Data stems from 9 775 companies.

— Number of exits: The total count of DTF companies that experienced their first “exit event” within the time period 2021-2024. An exit event is defined as a company’s first recorded transaction of the type “IPO” or “ACQUISITION”.

Table 4

Comparison of Deep Tech Finder (DTF) indicators among European startups with EP applications based on data from 2021-2024

	Number of startups	Number of deals	Total funding	Net jobs created	Number of exits
DTF startups with links to European research institutions	2 822	2 049	€58.97 billion	16 830	172
Share of all DTF startups (in %)	27.2%	30.6%	50.3%	26.9%	30.9%

Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

The analysis in Table 4 reveals that according to available data, research-based DTF startups contribute disproportionately to key startup success indicators in the period 2021-2024: while representing 27.2% of all DTF companies, they account for 50.3% of total funding raised (€58.97 billion), 30.6% of funding deals and 30.9% of successful exits. Only in terms of employment generation do the proportions align more closely, with research-based startups creating 26.9% of net jobs. By demonstrating that academic-patent linked ventures attract disproportionately high investment and achieve superior exit rates, this evidence validates the EU Startup and Scaleup Strategy's (European Commission, 2025)[10] emphasis on accelerating commercialisation of inventions from European research institutions and improving resources and skills and knowledge of European Technology Transfer Offices.

10 European Commission (2025, May 28). EU Startup and Scaleup Strategy. Directorate-General for Research and Innovation. https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/jobs-and-economy/eu-startup-and-scaleup-strategy_en

6. Concluding remarks

Public research organisations (PROs) are a cornerstone of Europe's innovation capacity, working alongside universities and research hospitals to generate scientific breakthroughs, develop advanced technologies and channel knowledge into industry. They take many forms, from large national institutes such as CNRS and Fraunhofer to smaller specialised applied research centres, shaped by different national governance models and funding structures. Universities receive the larger share of public R&D funding and dominate patenting activity among European research institutions. They are also the focus of extensive study in innovation research and the target of numerous EU initiatives and Europe-wide projects. Nonetheless, PROs hold a significant position in the European patent landscape, contributing 4.9% of all European patent applications filed by European applicants between 2001 and 2020. Yet their collective role remains less prominent in innovation and R&D circles, even as reforms are underway to strengthen commercialisation and promote deeper cross-border integration as a means of enhancing Europe's overall competitiveness.

This the first study to systematically map PRO patenting across Europe, following on from the EPO Observatory's 2024 report on European universities. It applies the concept of academic patents to patents filed at the European Patent Office, which includes both European patent applications filed directly by PROs and those filed by other entities, mostly from the industry, where at least one inventor is affiliated with a PRO. This combined applicant- and inventor-based approach reveals the full scope of PRO contributions in the European patent system, whether through their own IP portfolios or in collaboration with partners. By integrating this with comparative data on universities and research hospitals, the report provides a more complete view of Europe's public research landscape and how it engages with other actors in the innovation ecosystem.

The analysis reveals a highly diverse and uneven PRO ecosystem. Between 2001 and 2020, 252 PROs contributed to at least 20 European patent applications, yet just 16 of them accounted for almost 70% of all PRO-related academic patents. This concentration takes place with relevant differences across countries. France and Germany collectively produce almost 70% of all of Europe's PRO-related academic patents. While the overall patent numbers in Southern and Central Eastern European countries are lower than those in Western Europe, PROs play a highly significant role within their respective national innovation ecosystems.

Patent ownership patterns also differ across regions. In Western Europe, PROs often retain direct control, exceeding 90% in Benelux for example, whereas many Nordic and Central European countries, including Denmark, Norway, Sweden, Austria and the Czech Republic, have historically relied more on indirect patenting through industry partners. The trend in most countries, however, shows a shift towards greater direct ownership, except in Poland and the UK that stand out for increasing their share of indirect patents. This reflects different national strategies and institutional roles in technology transfer.

Comparisons of different institutions show that PROs, universities and research hospitals play distinct but complementary roles in the European patent system. PROs are more active in engineering-related and instrumentation fields, such as measurement technologies and semiconductors, while universities are more concentrated on inventions in pharmaceuticals and biotechnology, which together account for a third of all academic patents. Their approaches to patent ownership also differ: PROs maintain the highest direct-to-indirect ratio, universities have moved towards a near balance and research hospitals remain largely indirect, contributing inventions to patents held by other applicants.

Commercialisation indicators confirm the significant potential of PROs and their partners in Europe's innovation ecosystem. Startups linked to academic patents, whether originating from PROs, universities or research hospitals, punch well above their weight in attracting investment and achieving market success. These results point to an ecosystem with substantial assets, scientific excellence, valuable IP and strong capital-attraction capacity. This aligns with the EU Startup and Scaleup Strategy (European Commission, 2025), which seeks to valorise startups specifically originating from public research and to improve co-ordination among European organisations supporting startup growth and scaling.

The issue of European co-ordination is also evident in IP strategy choices, particularly in the uptake of the Unitary Patent (UP), which provides unitary protection

across 18 EU countries for granted European patents (as of October 2025). Universities have adopted the UP for 63.4% of their granted European patents, research hospitals for 54.2% but PROs for only 39.2%. Although some PROs are actively engaged, such as the CSIC in Spain or the CNR in Italy, the overall average remains lower, notably in France, Germany, Belgium and the United Kingdom. Given the UP's potential to simplify protection and extend market reach, such disparities suggest that even among research-intensive institutions, strategic approaches to exploiting IP vary widely. Closing this gap would not only improve the reach of PRO-generated innovations but also align commercialisation practices more closely with the opportunities of the single market. The EPO will continue to monitor future developments.

Taken together, these findings underline a persistent structural challenge: Europe's public research system has considerable strengths but remains fragmented across institutional and national lines. Co-ordination between countries and between different types of research organisations is uneven, which can limit the efficient translation of scientific results into market-ready innovations. Commercialisation pathways, particularly within PROs that have the scientific and technological capacity to contribute more, are not yet used to their full potential. Strengthening the visibility of these actors in the European patent system, and ensuring they can access the resources, skills and incentives to patent, collaborate and commercialise effectively, would contribute to a more integrated and competitive European innovation landscape.

These priorities align with the vision set out in the Enrico Letta report on the creation of a "fifth freedom" within the single market, removing barriers to the free circulation of research, innovation and knowledge alongside goods, services, capital and people, with policy initiatives such as the Unitary Patent. Addressing the gaps identified in this study would be a concrete step towards realising that ambition by enabling public research outputs to move more seamlessly across borders and sectors. Achieving this will require a clearer understanding of how different actors in the public research system operate and interact, and how their contributions can be co-ordinated more effectively.

Within this context, the EPO Observatory on Patents and Technology (epo.org/observatory) will continue to be involved through its 2026-27 Biennial Workplan, building the evidence base needed to inform these priorities. Alongside studies such as this one, the workplan will deliver further analytical tools, targeted events and practical insights to help stakeholders understand and address the structural barriers to more co-ordinated and effective innovation from public research. A key element will be a future analysis on technology transfer offices, which will examine how different commercialisation mechanisms through patenting, such as licensing or spin-off creation, are deployed across Europe's research institutions. By combining robust evidence on patent and technology data with practical tools for decision making, the Observatory aims to support a European research ecosystem that is better connected, resourced and positioned to translate knowledge into innovation.

Annex 1 Note on the methodology

The patent data for this study were extracted from the "EPO Worldwide Patent Statistical Database" (PATSTAT), which provides information about published patents collected from more than 80 patent authorities worldwide. In the study, we focus on patents filed at the European Patent Office and the patents in our analyses are counted according to their year of worldwide first filing, i.e. the priority year. This is the earliest registered date in the patent process and is therefore closest to the date of invention.

Up to this point, academic patents have only been analysed for universities. In this study, we for the first time focus on the identification of academic patents by public research organisations (PROs) and hospitals (either directly affiliated with a university or not).

For a good understanding of our analyses, the definition of "academic patents" is crucial. Recent literature established a basic differentiation between patents filed by the university/research organisation/hospital) ("university/PRO/hospital-filed patents") and patents filed by other applicants, while university/PRO/hospital employees were involved in the invention leading to the patent ("university/PRO/hospital-invented patents"). Both groups together are referred to as "academic patents" (Lissoni et al., 2008), either by universities, PROs or hospitals. University/PRO/hospital-filed patents are identified within the PATSTAT database with the help of keyword searches as well as existing classification systems and manual identification.

For the identification of universities, first of all, a keyword-based selection of research organisation (e.g. "univ%", "institute%", "faculty%", "tech%univ%", "hochschul%") is made. Here, different spelling variations and languages as well as a search for the names of the respective cities, also including spelling variations and languages, are taken into account. In the case of the Technical University of Munich, for example, patents are filed under the names "TECHNICAL UNIVERSITY OF MUNICH", "TECHNISCHE UNIVERSITAET MUENCHEN", or "TU MUENCHEN" etc. Once a keyword was found in the applicant information, this patent was counted as a university-filed patent. This keyword search was employed for all EPC member states and counted as university-filed patents. In order to assign these patents to a given country, the country of the patent applicant was used.

For the identification of hospital-filed patents, the sector classification provided by the K.U. Leuven in PATSTAT was used. All applicants that were marked as "COMPANY HOSPITAL", "GOV NON-PROFIT HOSPITAL" or "HOSPITAL" in the K.U. Leuven classification were flagged as hospitals. In addition, keyword searches (e.g. "hospital%", "klinik%", "clinic%", "hôpital%", "%uni%klinik%") in different spelling variations were made. This was also employed for all EPC member states. In order to assign these patents to a given country, the country of the patent applicant was used.

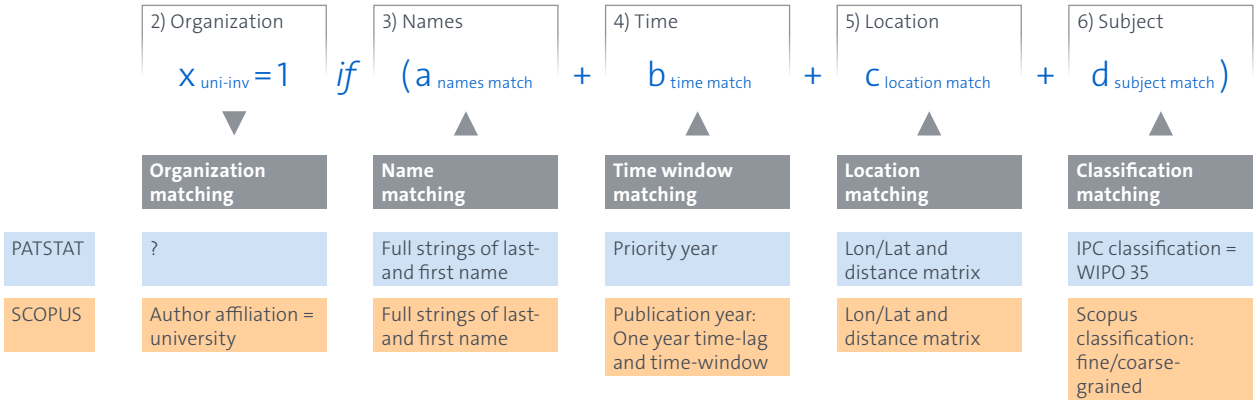
For the identification of PROs, a negative selection including manual corrections was made. All applicants in PATSTAT that were not marked as universities or hospitals (via the methodology described above), single inventors (where inventor name = applicant name) or companies (identified via the legal status, e.g. AG, GmbH, A/S, S.A., S.R.L), entered the pool of potential PROs. From there, a manual selection was made on whether an applicant was considered a PRO or not. The decision of classifying an applicant as a PRO was based on the list of PROs provided by OrgReg, a list of PROs provided by EARTO as well as information based on EPO internal sources.

The approach for the identification university/PRO/hospital-invented patents is based on the examination of name matches of authors of scientific publications found in the bibliometric database Scopus and inventor names from PATSTAT. Patents do not indicate the employing institution of an inventor, while the publications list the authors' affiliation and enable us to identify academic inventors and the patents they have contributed to. This allows us to connect these patents to the publications of those university/PRO/hospital employees, with the limitation that a university/PRO/hospital employee must have at least one publication listed in Scopus in order to be identifiable by our algorithm. University personnel that has not (yet) published in a journal listed in Scopus cannot be taken into account by our methodology. After the matching of authors from Scopus to inventors from PATSTAT, these matches were flagged accordingly and assigned a unique ID, which serves as a link between the patents and publications generated by these individuals. A more detailed description of the matching and its validation can be found in Dornbusch et al. (2013).

The chosen approach exploits relatively large amounts of data and this raises the danger of erroneous matches between person names. This is mainly due to increasing numbers of homonyms, i.e. different persons having identical names. Therefore, the application of additional selection criteria is required in order to ensure an algorithm that matches inventor and author data as precisely as possible (Figure A1).

Figure A1

Selection criteria for academic patents



Source: Adapted from Dornbusch et al. (2013).

In order to identify universities, PROs and hospitals in Scopus, the same keyword search as in the case of PATSTAT was applied. The selection criteria for the reduction of homonyms were:

— A time window of two years between a patent and a given publication.

— The match of the inventor address with the location of the university/PRO/hospital. Here, the longitude and latitude information from a geocoding of addresses in PATSTAT and Scopus was applied. The geocoding algorithm was taken from the open-source project Pelias. Pelias is a modular geocoder built on top of the search engine Elasticsearch. It uses several open-source geographic datasets (Who's on First, OpenAddresses, OpenStreetMap and Geonames). Addresses are parsed and normalised with libpostal, which uses statistical NLP and open data. Elasticsearch then converts the normalised address into a longitude/latitude location. To address the problem of people commuting from their home to their work place, we additionally worked with a distance matrix. As a standard, a distance of 20km was used.

In order to ensure a content-related correspondence between the matched documents, a concordance between technology fields, based on the current WIPO35 classification (Schmoch, 2008) and science fields within Scopus, was employed at a rather aggregated level of five broad fields/technology areas.

For the evaluation of the algorithm, a recall and precision analysis has been applied (Baeza-Yates and Ribeiro-Neto, 2011). The combination of full names with the location criterion as well as the subject match obviously achieves the best results (F-Score: 0.92), particularly when giving precision a higher priority over recall.

Another challenge that had to be tackled was the assignment of patents from universities, PROs and hospitals (filed as well as invented) to organisation names at the micro level as there is no name harmonisation in PATSTAT or in Scopus, i.e. there is no unique identifier for single universities, PROs or hospitals in the two databases. We therefore had to rely on an external data source that lists unique IDs for universities, namely OrgReg.

OrgReg is a public facility, providing a comprehensive register of public sector research and higher education

organisations in European countries. It defines a common list of organisation names and unique organisational identifiers. With the help of the OrgReg data, we were able to create an aggregation of university/PRO/hospital names in PATSTAT and Scopus for all universities of EPC member states. All universities, PROs and hospitals from Scopus as well as university/PRO/hospital applicants identified in PATSTAT were matched to the OrgReg data based on a string matching algorithm. To avoid double counting across datasets, all entities categorised as "research hospital", "HEI, research hospital", or "PRO, research hospital" were treated as hospitals.

For the matching, several steps had to be performed:

1. Data cleaning: removal of legal forms, umlauts, special characters, etc. from university names
2. Match exact name of the university/PRO/hospital + country
3. Match similarity of the name of the university/PRO/hospital + country
4. Match exact English university/PRO/hospital name + country
5. Match similarity of the English university/PRO/hospital name + country
6. Match university acronym + country
7. Match city (e.g. Berlin) + general keyword search ("univ", "tech", etc.) + country
8. Repeat steps 2-7 without country comparison
9. Manual match of largest universities/PROs/hospitals
10. In PATSTAT: repeat for the harmonised hrm-l2 name from KU Leuven, doc_std_name and person_name. In Scopus: only organisation name
11. Complement with information provided by the EPO and national offices participating in the process

Steps 6 to 8 were only carried out for universities, not for PROs and hospitals.

In Table 1, the results of the matching are displayed. The matching rate is much lower for organisations in Scopus as there is no university/PRO/hospital name standardisation at all, i.e. every author lists affiliation names differently, so there is a huge variation in affiliation names. For university/PRO/hospital-filed patents this is much easier, as we can rely on pre-existing name harmonisations. However, we can see from the lower panel of Table 1 that nearly all patents from universities are assigned to an OrgReg-ID. Although this share is somewhat lower for PROs and hospitals, we are able to assign a large share of entities to an OrgReg ID.

Table A1

Share of patent applicants and Scopus affiliations (upper panel) and of academic patents (lower panel) assigned to an OrgReg-ID

Type	Share of matched applicants (Uni/PRO/hospital-filed)	Share of matched applicants (Uni/PRO/hospital-invented)
Universities	93%	69%
PROs	66%	30%
Hospitals	85%	22%

Type	Share of matched applicants (Uni/PRO/hospital-filed)	Share of matched applicants (Uni/PRO/hospital-invented)
Universities	97%	99%
PROs	90%	76%
Hospitals	95%	78%

Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

Annex 2 Main PROs with academic patents in European countries (2001-2020)

The tables below feature the top 10 PROs for the top two countries and the top three PROs (with at least 25 academic patents) for the remaining countries. The ranking is based on the number of European patent applications filed for academic patents, including both direct applications filed by the PROs, and indirect applications filed by other applicants with a PRO-affiliated researcher listed among the inventors. By virtue of this definition, the ranking ignores academic inventions for which a patent application may have been filed at another patent office than the EPO.

Table A2

Top PROs by country

France	
National Centre for Scientific Research (CNRS)	10 271
The French Alternative Energies and Atomic Energy Commission (CEA)	8 960
The National Institute of Health and Medical Research (INSERM)	3 940
IFP Energies nouvelles (IFPEN)	1 880
Institut Pasteur	764
National Research Institute for Agriculture, Food and Environment (INRAE)	660
National Institute for Research in Digital Science and Technology (INRIA)	528
National Centre for Space Studies (CNES)	420
Institut Curie	392
The French Aerospace Lab (ONERA)	147

Germany	
Fraunhofer Society for the advancement of applied research (Fraunhofer)	7 852
Max Planck Society for the Advancement of Science (MPG)	2 195
German Aerospace Center (DLR)	1 046
German Cancer Research Center (DKFZ)	903
Jülich Research Centre (FZJ)	850
Helmholtz Munich - German Research Center for Environmental Health	456
Helmholtz Centre for Infection Research	290
Max Delbrück Center for Molecular Medicine in the Helmholtz Association	260
Helmholtz Centre Hereon	253
GSI Helmholtz Centre for Heavy Ion Research	235

The Netherlands	
Netherlands Organisation for Applied Scientific Research (TNO)	2 923
Netherlands Organisation for Scientific Research (NWO)	187
Netherlands Cancer Institute	140

Belgium	
Interuniversity Micro Electronics Center (IMEC)	2 195
Flanders Institute for Biotechnology (VIB)	396
VITO - Flemish Institute for Technological Research	300

Spain	
Spanish National Research Council (CSIC)	1 069
Catalan Institution for Research and Advanced Studies (ICREA)	266
Consorcio Centro de Investigación Biomédica en Red (CIBER)	182

Italy	
National Research Council (CNR)	439
Italian Institute of Technology (IIT)	269
National Institute for Nuclear Physics (INFN)	116

Switzerland	
Swiss Center for Electronics and Microtechnology (CSEM)	369
Swiss Federal Laboratories for Materials Science and Technology (EMPA)	329
Paul Scherrer Institute (PSI)	309

United Kingdom	
Defence Science and Technology Laboratory (DSTL)	228
Medical Research Council of the United Kingdom (MRC)	210
UK Research and Innovation (UKRI)	97

Finland	
VTT Technical Research Centre of Finland	740
Finnish Red Cross[11]	35
National Institute for Health and Welfare	30

11 The Finnish Red Cross Blood Service actively filed patent applications in the early 2000s. Since then, the organization's R&D strategy has shifted significantly, and patenting is no longer part of its approach. Previous patents and patent applications have been abandoned as part of this strategic transition.

Poland	
Polish Academy of Sciences (PAN)	395
Siec Badawcza Lukasiewicz network	262

Austria	
AIT Austrian Institute of Technology	227
Joanneum Research	91
Institute of Molecular Biotechnology (IMBA)	64

Denmark	
Statens Serum Institut (SSI)	213
Danish Technological Institute	96
National Research Centre for the Working Environment	75

Czech Republic	
Academy of Sciences of the Czech Republic	323

Norway	
Sintef	202
Institute for Energy Technology	51

Sweden	
Swedish Defence Research Agency (FOI)	76
Science for Life Laboratory	69

Portugal	
Institute for Systems and Computer Engineering (INESC TEC)	47
Telecommunications Institute (IT)	30

Luxembourg	
Luxembourg Institute of Science and Technology (LIST)	182
Luxembourg Institute of Health (LIH)	32

Slovenia	
National Institute of Chemistry (KI)	85
Jozef Stefan Institute	63

Hungary	
Hungarian Academy of Sciences	80
MTA Biological Research Centre, Szeged	31

Greece	
National Center For Scientific Research 'Demokritos'	53
Foundation For Research And Technology Hellas (FORTH)	34

Latvia	
Latvian Institute of Organic Synthesis (OSI)	95

Slovakia	
Slovak Academy of Sciences (SAS)	46

Lithuania	
Center for Physical Sciences and Technology (FTMC)	45

Bulgaria	
Bulgarian Academy of Sciences (BAS)	28

Croatia	
Ruđer Bošković Institute	28

Türkiye	
Scientific and Technological Research Council of Türkiye (TUBITAK)	80

Annex 3 Main European research hospitals with academic patents (2001-2020)

Table A3

Top European research hospitals

Nr.	Name of institution	Country	Academic patents
1	Assistance publique Hopitaux de Paris (AP-HP)	FR	1 968
2	Copenhagen University Hospitals (CUH)	DK	1 439
3	Karolinska University Hospital	SE	479
4	Heidelberg University Hospital (UKHD)	DE	420
5	Charité - University Medicine Berlin	DE	394
6	Imperial College Healthcare NHS Trust	UK	385
7	University Medical Center Freiburg	DE	369
8	University Hospital Zurich (USZ)	CH	364
9	University Hospital of Lausanne (CHUV)	CH	356
10	Skane University Hospital (SUS)	SE	348
11	University Hospital Basel	CH	317
12	Gustave-Roussy Institute	FR	276
13	Cancer Research UK	UK	272
14	Oslo University Hospital	NO	263
15	Grenoble University Hospital (CHU Grenoble)	FR	242
16	Sahlgrenska University Hospital	SE	241
17	Oxford University Hospitals NHS Foundation Trust	UK	240
18	Nantes University Hospital (CHU Nantes)	FR	231
19	University Hospitals Leuven (KU Leuven, Gasthuisberg Campus)	BE	209
20	Aarhus University Hospital	DK	206
21	Leiden University Medical Center (LUMC)	NL	187
22	Erlangen University Hospital	DE	183
23	Geneva University Hospitals (HUG)	CH	181
24	Marseille University Hospitals (AP-HM)	FR	174
25	Lille University Hospital	FR	174

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