



DANISH PATENT AND
TRADEMARK OFFICE

Life science

Report



Preface

Danish life science enterprises are among the leaders in the global market for pharmaceuticals, medical devices, and biotechnology. A strong health care system and leading research has led life science to become a central Danish position of strength. The industry has almost tripled its exports over the past 10 years, and exports amounted to 142 billion DKK (20 billion Euro) in 2019, making up about 19 pct. of the total export of goods from Denmark¹. The life science industry is also contributing to green transitioning. The industry has reduced its environmental footprint by 50 pct. since the 1990s, while simultaneously ten-folding its value creation. The industry is therefore contributing to the government's long-term goal of climate neutrality by 2050 while also developing new solutions to remedy current health challenges.

The Danish life science sector holds a strong position in the field of patents, especially when looking at the number of applications per million inhabitants, and this report shows that the number of patent applications from Danish enterprises has been stable over the past 10 years. During the same period, however, Chinese enterprises have more than five doubled the number of applications to the European Patent Office (EPO) and the United States Patent and Trademark Office (USPTO). Patents provide an important incentive to continuous innovation and value creation in

society as a whole. Therefore, we must continue to strengthen the conditions for the industry to maintain the high level of development and utilize the latest research. This requires a sustained focus on strengthening innovation, research, and product development by creating a good framework for future growth and jobs.

The Danish Patent and Trademark Office has analysed the innovativeness of the Danish life science industry based on their patent activity. This analysis examines to which extent Danish, Swedish, Swiss, German, American, and Chinese enterprises within the life science industry use patents to protect their innovations. The analysis helps shed light on the development of new, patented innovations in the life science industry as well as trends in applications to the USPTO and EPO.

The analysis also provides interesting insight into the Danish life science industry's performance and development within patenting of life science technologies and products in recent years.

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¹ Erhvervsministeriet, 2020, *Life science industriens fodaftryk*: <https://em.dk/media13844/det-oekonomiske-fodaftryk-af-life-science-opdateret.pdf>

Introduction

The life science industry has many costs associated with R&D spending, product development, and clinical trials². With intense international competition in life science, it is important that enterprises can use patenting to protect and commercialize their technology³. Patents are therefore vital in order to ensure incentives for enterprises to commit to the high costs related to R&D.

By comparing the number of patents from Danish enterprises with international competitors, the analysis provides insight to the use of patenting in the life science industry as well as the position of Danish life science industry in relation to the global life science industry. For the purpose of this analysis, life science enterprises are defined as enterprises operating in the areas of pharmaceuticals, medicinal products, biotechnological, and food chemistry⁴.

Patents - what is it all about?

- A patent is an exclusive right to a product or a process that provides a new technical solution to a problem. To get a patent, the technical information about the invention must be disclosed in a patent application.
- Patents can be valid in a time period of up to 20 years from the filing date of the patent application.
- Patents are territorial rights. In general, the exclusive rights are only applicable in the country or region in which a patent has been filed and granted, in accordance with the law of that country or region.
- Patents have played a crucial role in the technical development from electric lighting to the invention of microprocessors. Patents provide incentives to technological development, protection of R&D investments, opportunities for commercialization and trade. Thus, a patent gives the inventor a recognition of creativity as well as financial incentives to invest in R&D. At the same time, the obligatory publication of patents and patent applications facilitates the mutually beneficial spread of new knowledge and accelerates innovation. In other words, the public disclosure of the technical knowledge in the patent, and the exclusive right granted by the patent, provide incentives for competitors to gain inspiration from the first invention.

² <https://www.copcap.com/set-up-a-business/key-sectors/life-sciences>

³ <https://em.dk/media/13905/det-oekonomiske-fodaftryk-af-life-science-ny.pdf>

⁴ For further information see the method chapter.

The Danish life science industry keeps a stable level of patent applications

Looking at the total number of patent applications (see figures 1 and 2), it is clear that the number of patent applications from US enterprises is significantly higher than the enterprises from other countries in this study. As shown in figure 1, the number of patent applications to the United States Patent and Trademark Office (USPTO) from US enterprises is ten times higher than from any other country. The number of patent applications from Danish enterprises is the second lowest in terms of total number of applications to both the European Patent Office (EPO) and the USPTO. However, this is obviously also a reflection of the difference in size of the countries' population (see figures 3 and 4).

Looking at the trends, the number of patent applications has been rising from 2010-2019 from both US and Chinese enterprises to both the EPO and the USPTO (see figures 1 and 2). Chinese enterprises have generated the largest growth in life science patent applications and

have more than five doubled the number of applications to the USPTO and the EPO. During the same period, US enterprises have experienced an increase in the number of patent applications of 44 pct. to the USPTO and 32 pct. to the EPO, while most other countries have maintained a more constant level.

As an example, Denmark has experienced a small decline of 2 pct. in the number of patent applications to the EPO and an increase to the USPTO of 13 pct. during the ten-year period.

Both the European and the US market seem to be of high importance for Danish life science enterprises, as the number of patent applications to the USPTO and the EPO is relatively similar. However, there seems to be a trend towards an increasing focus on the US market compared to the European market during the period from 2010-2019.

Development in life science patent applications to the USPTO

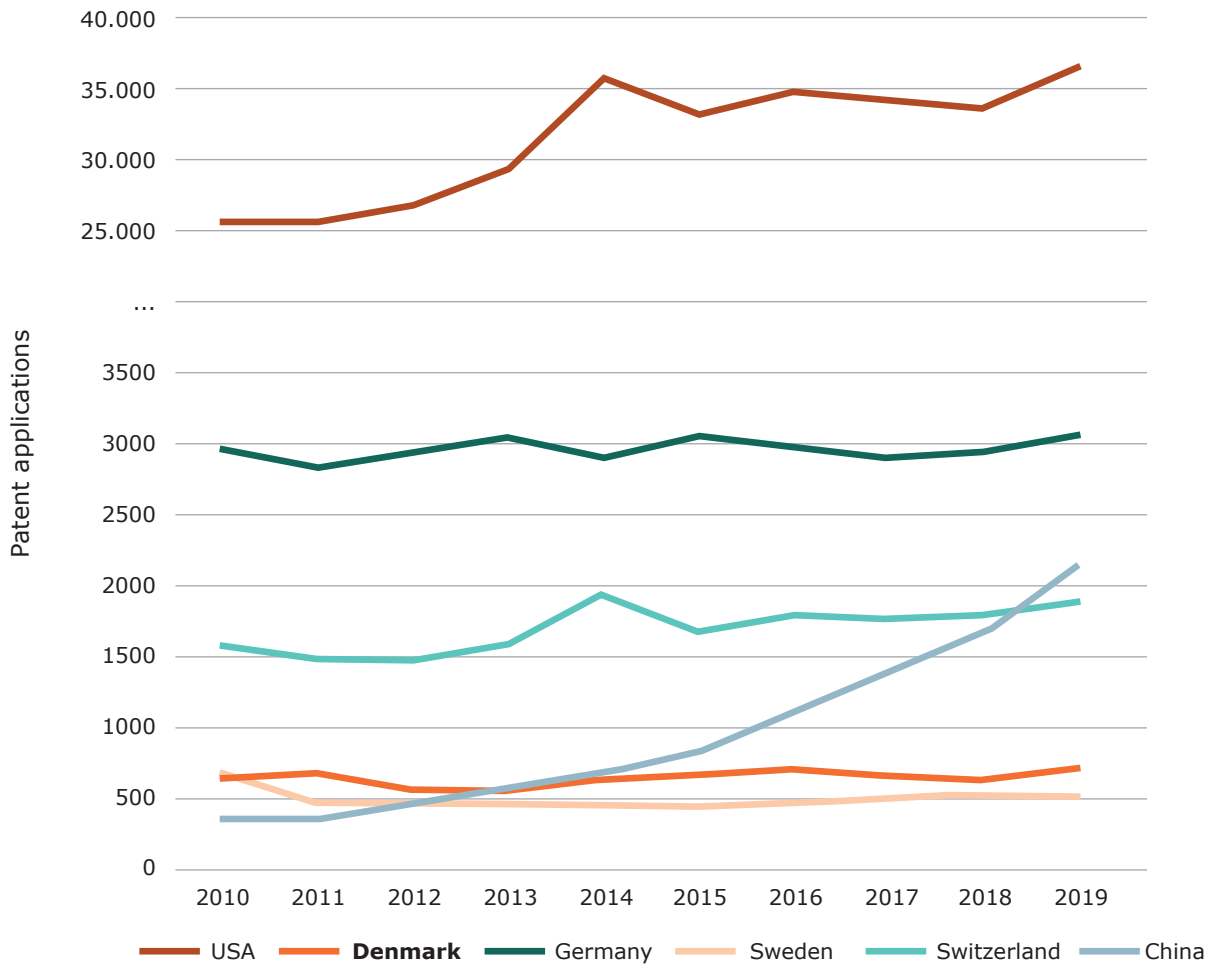


Figure 1 Number of patent applications to the USPTO within life science

Development in life science patent application to EPO

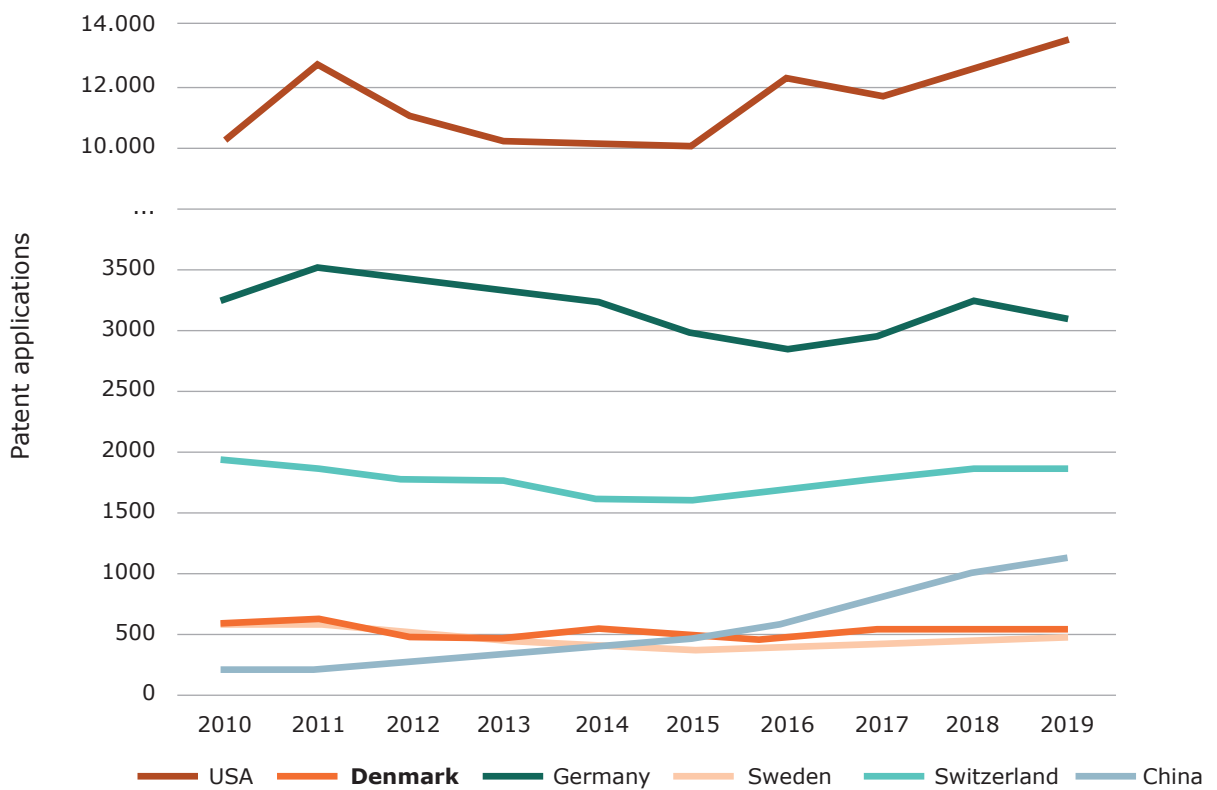


Figure 2 Number of patent applications to the EPO within life science

Denmark has a clear position of strength within life science

As shown, there has been a relatively steady development in the number of patent applications within life science from most countries over the past 10 years (see figures 1 and 2), with the exception of the USA and in particular China, which have seen a clear increase.

Looking at the relative strength between the countries (as measured by patent applications per million inhabitants), Switzerland generally performs better than the rest of the countries in the study. At the other end of the scale, China has the lowest number of life science patent applications per million inhabitants

placing the country far behind the other countries in the study. Germany and Sweden are all in the middle with approximately the same number of patent applications per million inhabitants. Denmark and Switzerland along with the USA differ positively from the other countries measured by the number of patent applications to the USPTO per million inhabitants. At the same time, Denmark and Switzerland have a clear position of strength in the number of applications to the EPO (figures 3 and 4). Denmark and the USA still have significantly fewer patent applications per million inhabitants compared to Switzerland.

Life science patent applications to USPTO - per million inhabitants

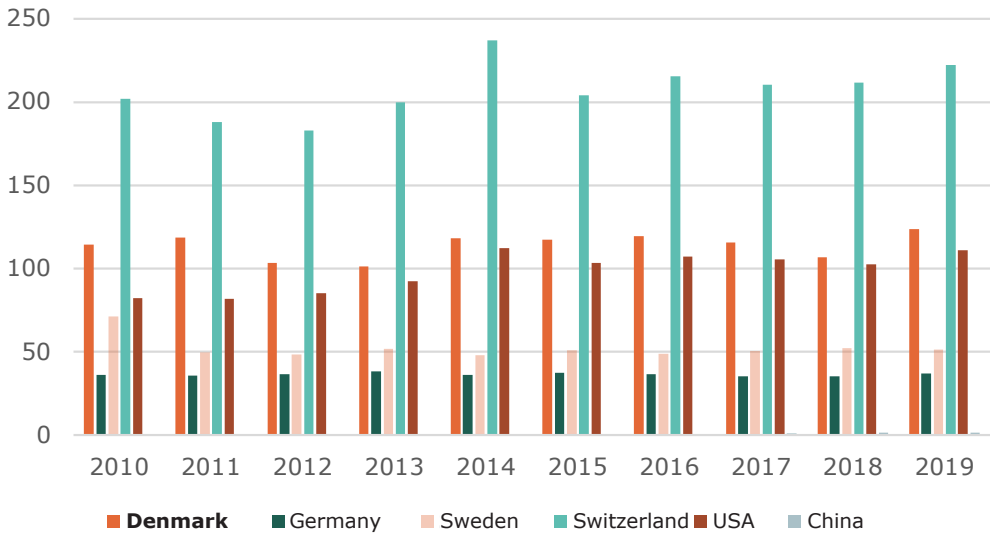


Figure 3 Patent applications per million inhabitants to USPTO

Life science patent applications to EPO - per million inhabitants

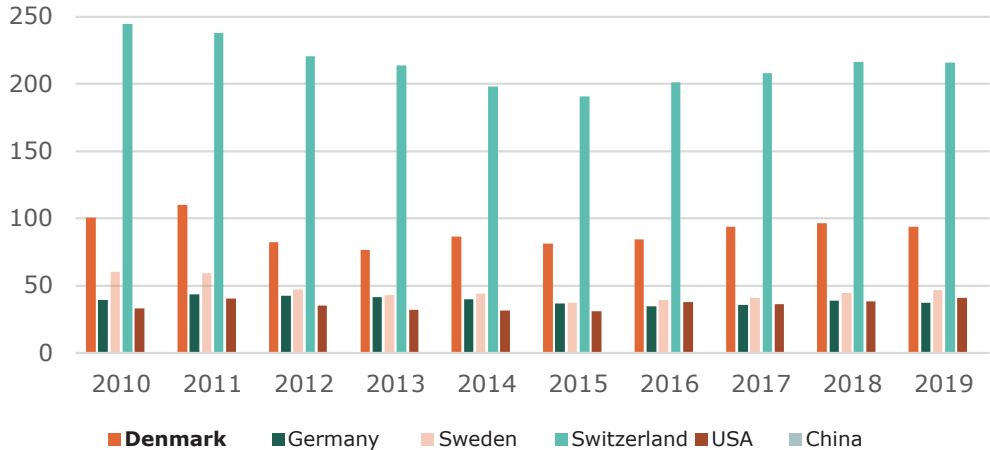


Figure 4 Patent applications per million inhabitants to EPO

The USA has the biggest export market for Danish life science industry

The USA is the largest export market for the Danish life science industry and is valued at 28 billion DKK (3,8 billion Euro) in 2018 which is a 21 pct. increase compared to 2017⁵. The importance of the US market also translates into patenting. The Danish life science industry filed 26 pct. more patent applications to the USPTO than to the EPO between 2010-2019 (see figure 5). In that period, Swedish, American,

and Chinese enterprises also filed more patent applications to the USPTO than to the EPO, while the reverse is the case for German and Swiss enterprises. As shown in figures 5 and 6, only American and Chinese enterprises have a significantly higher proportion of patent applications to the USPTO than the EPO.

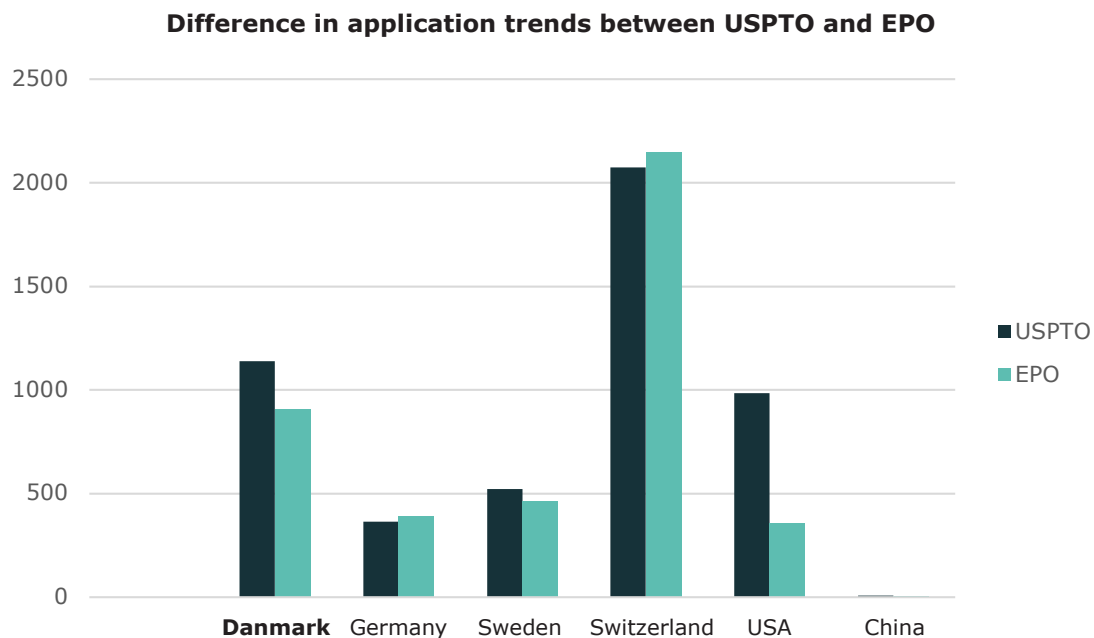


Figure 5 Accumulated patent applications to the USPTO and the EPO from 2010-2019 per million inhabitants (see figure 6 for a more detailed view of applications by Chinese enterprises).

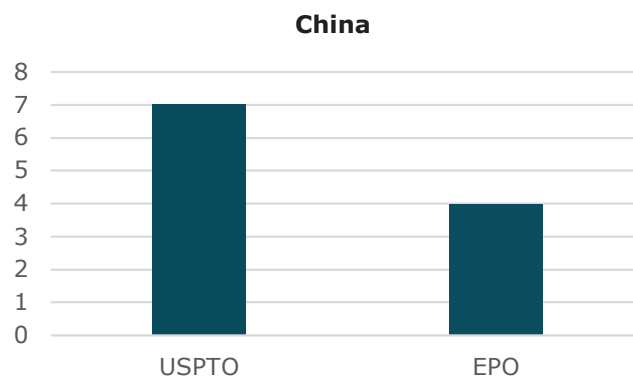


Figure 6 specification of China's patent trend – accumulated patents to the USPTO and the EPO from 2010-2019 (per million inhabitants)

⁵ www.ft.dk/samling/2019/almindel/ERU/bilag/109/2126822/index.htm

Difference in technological strengths within the life science industry

As shown in figures 7 and 8, Danish patent applications are widely dispersed between technology classes, and this testifies to the diversity of the Danish life science industry. The largest field of technology in Danish life science is biotechnology. The share of patent applications within food chemistry is also quite high (compared

to the equivalent share in the other countries) underlining the fact that Denmark holds particularly strong positions in these fields of technology. Compared to the other countries, the share of patent applications from Danish enterprises within pharma and especially medical devices is lower than in the other countries.

Distribution of technology field (USPTO)

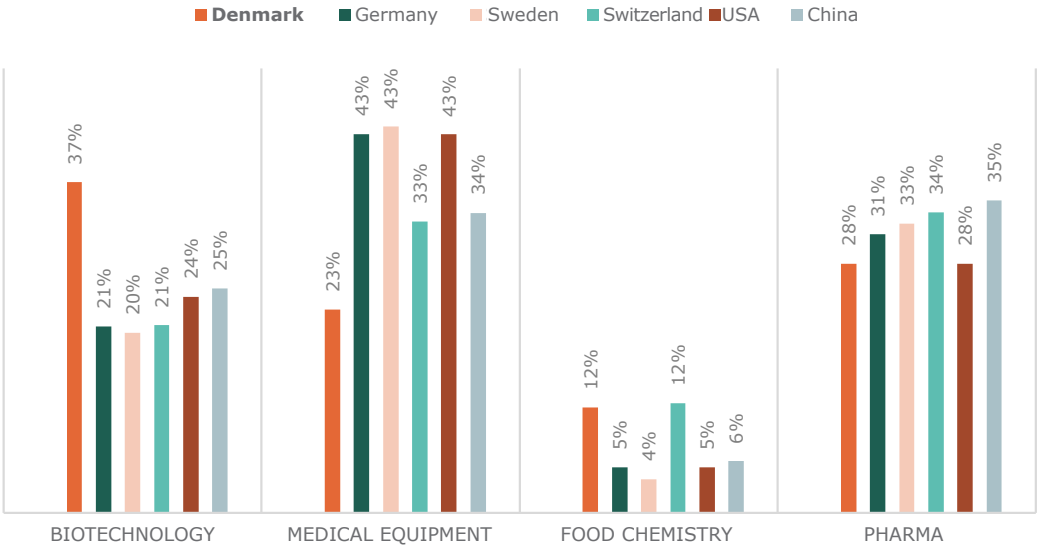


Figure 7 All life science patent applications for each country distributed in the various technology fields accumulated from 2010-2019 to the USPTO.

Distribution of technology fields (EPO)

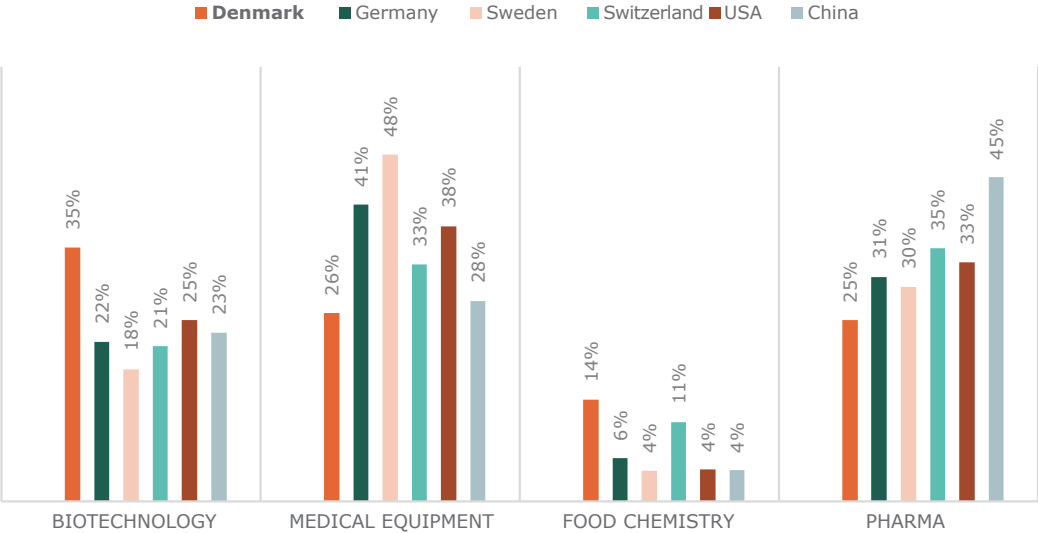


Figure 8 All life science patent applications for each country distributed in the various technology fields accumulated from 2010-2019 to the EPO.

Danish life science patent applications to the world's largest IP offices

In the previous sections, the number of life science patent applications has been based on applications filed with the EPO and the USPTO. This approach to measuring the number of patent applications is somewhat biased towards the American and European enterprises which are, all other things being equal, more likely to file for patents in their home markets.

In this section, performance is based on the number of patent applications filed at the USPTO or the EPO and at one or more of the other largest IP offices in the world (IP5 – USA, EPO, China, Japan, and South Korea). Due to the availability of data, the following figures will be based on a 10-year period from 2006 to 2015.

Figure 9 shows the number of patent applications to two or more offices of the IP5 each year from the six countries. As seen throughout this report, Switzerland is significantly ahead in comparison with the other countries measured per million inhabitants. Denmark is also performing well and has a substantially higher number of patent applications per million inhabitants compared to Germany, the USA, China, and Sweden. In addition, countries generally maintain a relatively stable level of patent applications throughout the period, although with a slightly declining trend. China has seen a significant increase over the same period (see figures 9 and 10).

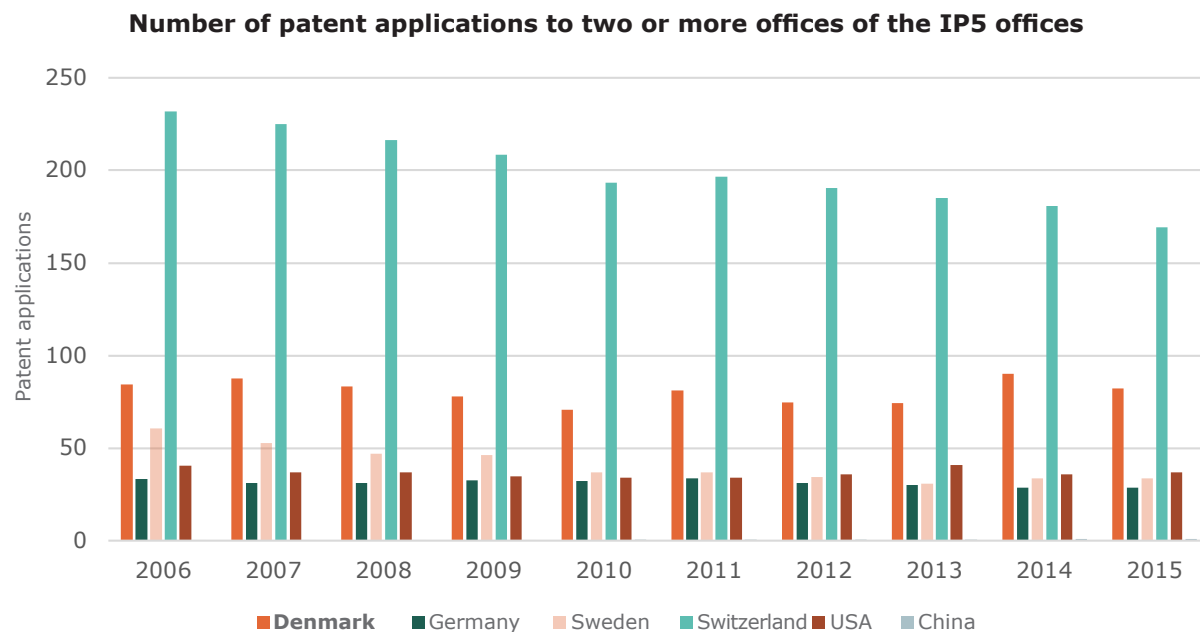


Figure 9 – Number of patent applications for two or more offices in the IP5 offices (per million inhabitants) in life science (see figure 10 for a more detailed view of applications from Chinese enterprises)

Number of Chinese patent applications for two or more offices among the IP5 offices

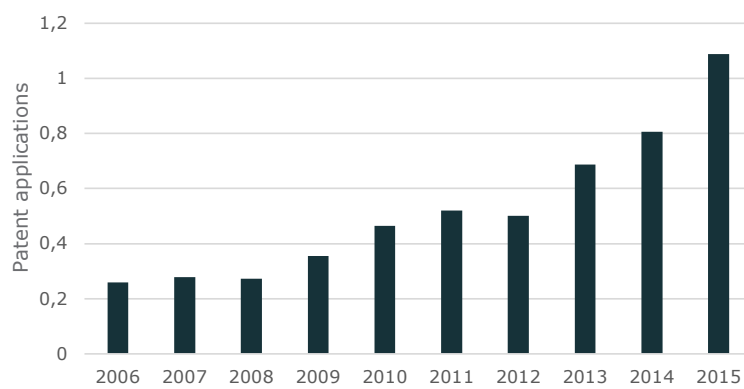


Figure 10 Specification of the number of Chinese patent applications for two or more offices in the IP5 offices (per million inhabitants) in life science

Life science constitutes a large share of Danish patent applications to the IP5 offices

Life science is a crucial industry for Denmark, providing many jobs and contributing to a large share of Denmark's exports. This is reflected by the share of life science patent applications out of the total number of patent applications filed by Danish enterprises. As shown in figure 11, Danish life science makes up for a larger share of total number of patent applications than all other countries in this report, indicating the vital role this industry plays in Denmark.

However, the life science industry's share of the total number of patent applications has been decreasing in Denmark (as in all the countries); from 52 pct. in 2006 to 40 pct. in 2015. As shown earlier in the report, the trends in figure 11 cannot necessarily be seen as a recession in the industry in general, however rather as a result of a growing number of patent applications in other technology areas.

Life science share of all patent applications to the IP5 offices

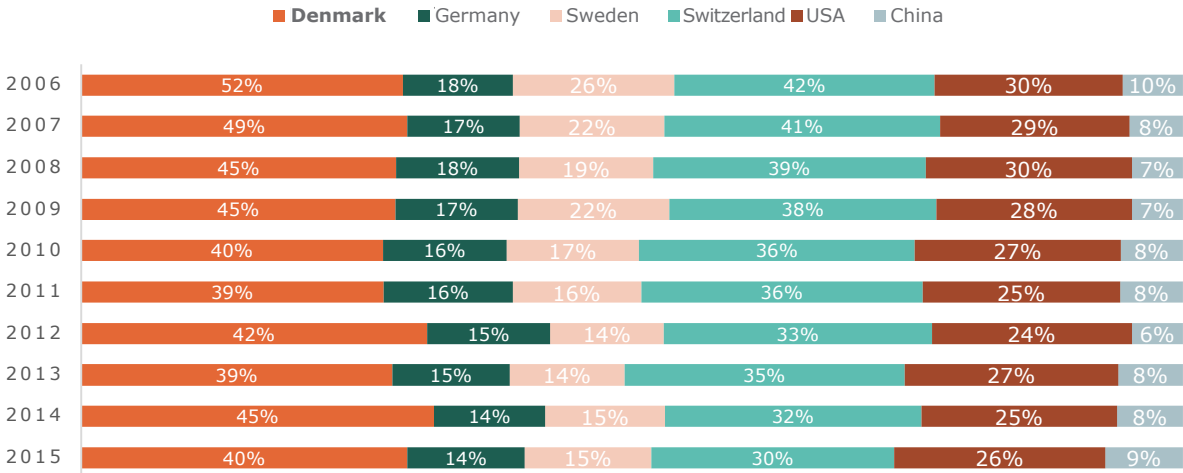


Figure 11 The figure is based on patent applications filed to the USPTO/EPO and one of the other IP5 countries

Large enterprises account for almost all patent applications

So far, the analysis has revealed that Danish life science is doing very well in an international context and may be considered among the world leaders when it comes to life science patents. This testifies to a high level of competitiveness in the Danish life science industry. However, in order to maintain a high level of competitiveness, a strong ecosystem of young enterprises providing new innovative solutions and contributing to a high level of competition is important. It is therefore relevant to take a closer look at the Danish life science industry to increase the understanding of which enterprises are driving the innovation and patenting.

As shown in figure 12, Novozymes and Novo Nordisk are the two most patent active Danish enterprises within the life science industry. Combined, they account for 25 pct. of all Danish life science patent applications (from 2005-2015). Moreover, the ten most patent active enterprises account for almost 50 pct. of all life science patent applications in this period. This indicates that life science is a concentrated industry where large enterprises file the majority of the patent applications. In comparison, however, the ten most patent active Danish enterprises in the green tech industry (all large enterprises) account for 73 pct. of all patent applications with Vestas and LM Wind Power alone accounting for almost 47 pct. of all green tech patent applications.

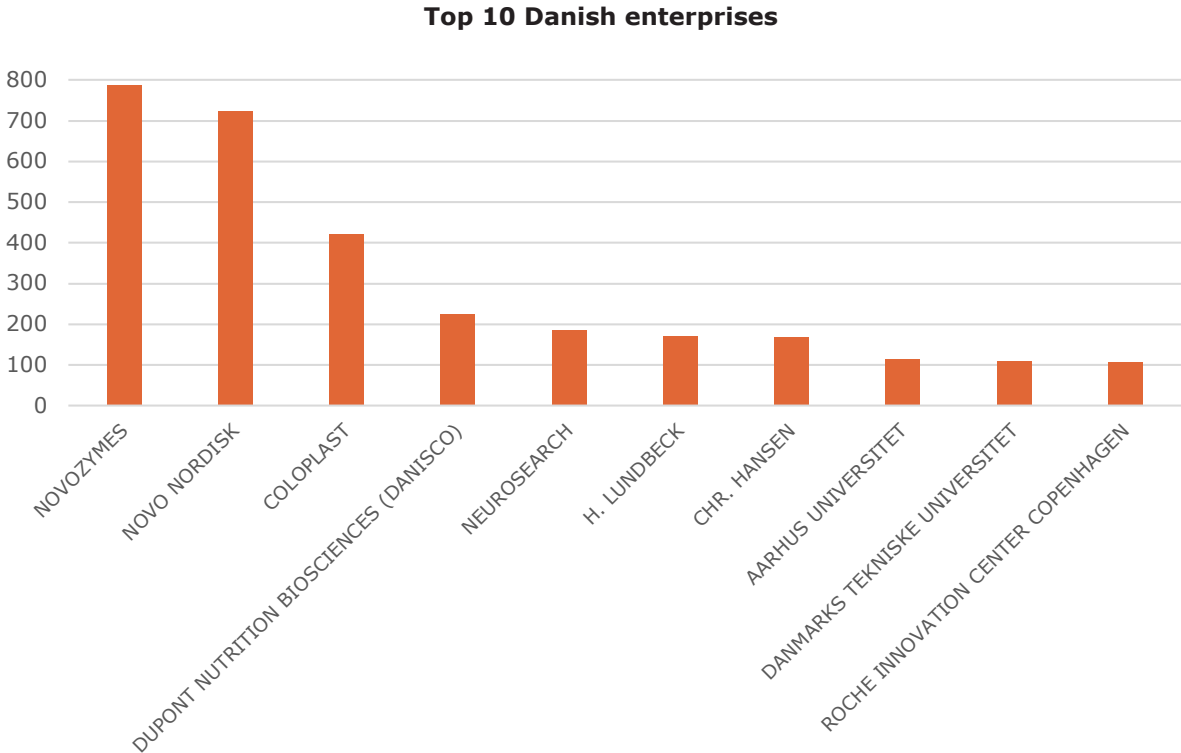


Figure 12 Denmark's top 10 most patent-active enterprises (accumulated patent applications from 2005-2015)

The role of SMEs in life science patenting

Despite the fact that large enterprises are responsible for a large share of all patent applications, there seems to be a well-working

eco-system of small patent active Danish life science enterprises (see table 1 for explanation).

| | Micro-enterprises | Small enterprises | Medium enterprises |
|---------------------|-------------------|-------------------|--------------------|
| Number of employees | 0 to 9 | 10 to 49 | 50 to 249 |
| Balance sheet | 2.7 million DKK | 44 million DKK | 156 million DKK |
| Revenue | 5.4 million DKK | 89 million DKK | 313 million DKK |

Table 1 Overview of the limit values defining the different enterprise sizes (two or more of the limit values must be exceeded if an enterprise is to move from one class to a larger). Source: Bekendtgørelse af årsregnskabsloven.

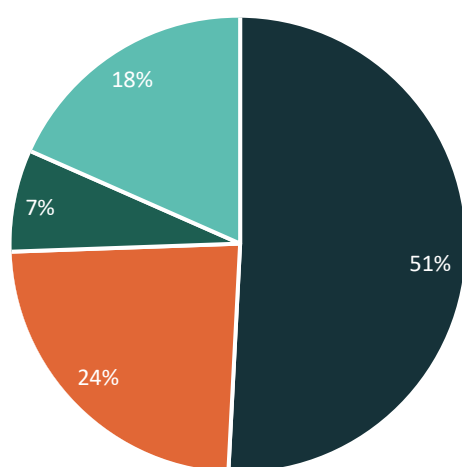
As shown in figure 13, SMEs make up the majority (82 pct.) of the enterprises that have applied for at least one patent. Thus, there seem to be many innovative SMEs within the life science industry. Micro-enterprises make up the largest share of SMEs with patent applications (51 pct. of all patent active enterprises) followed by small enterprises (24 pct.) and medium-sized enterprises (7 pct.).

In an isolated perspective, micro-enterprises account for almost 45 pct. of all patent applications from SMEs. This is interesting in relation

to the investment potential in micro-enterprises within the life science industry, and it suggests that there is a well-working ecosystem for life science startups in Denmark.

However, despite making up 82 pct. of the patent active enterprises, SMEs account for only 26 pct. of all patent applications (see figure 14). Large enterprises – despite making up only 18 pct. of all patent active Danish life science enterprises – dominate in terms of the total amount of patent applications in life science.

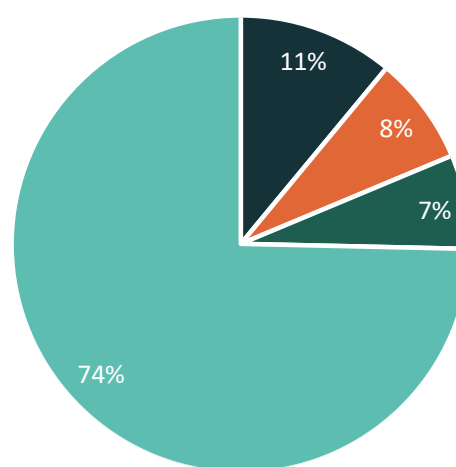
Breakdown by enterprise size



■ Micro enterprises ■ Medium enterprises
■ Small enterprises ■ Large enterprises

Figure 13 Breakdown of Danish patent active enterprises by size (accumulated patent applications from 2005-2015)

Proportion of patents by enterprise size



■ Micro enterprises ■ Medium enterprises
■ Small enterprises ■ Large enterprises

Figure 14 Breakdown of patent applications on enterprise size (accumulated patent applications from 2005-2015)

Based on filing data, it is evident there is a large cluster of SMEs contributing to the

innovative development of new inventions and products in the Danish life science industry.

Average number of patents by enterprise size

When looking at the number of life science patents per enterprise, it is clear that larger enterprises have much greater patent portfolios on average than SMEs. Large enterprises submit the highest average number of patent applications, averaging 37 applications per enterprise (see figure 15). Figure 15 shows the average number of applications by enterprise size. As shown in the figure, micro-enterprises have on average the fewest applications,

followed by small enterprises, while medium-sized enterprises have the most applications in the SME-segment on average. The average number of patent applications per SME is around 3, which is significantly lower than for large enterprises.

Average number of patents per enterprise

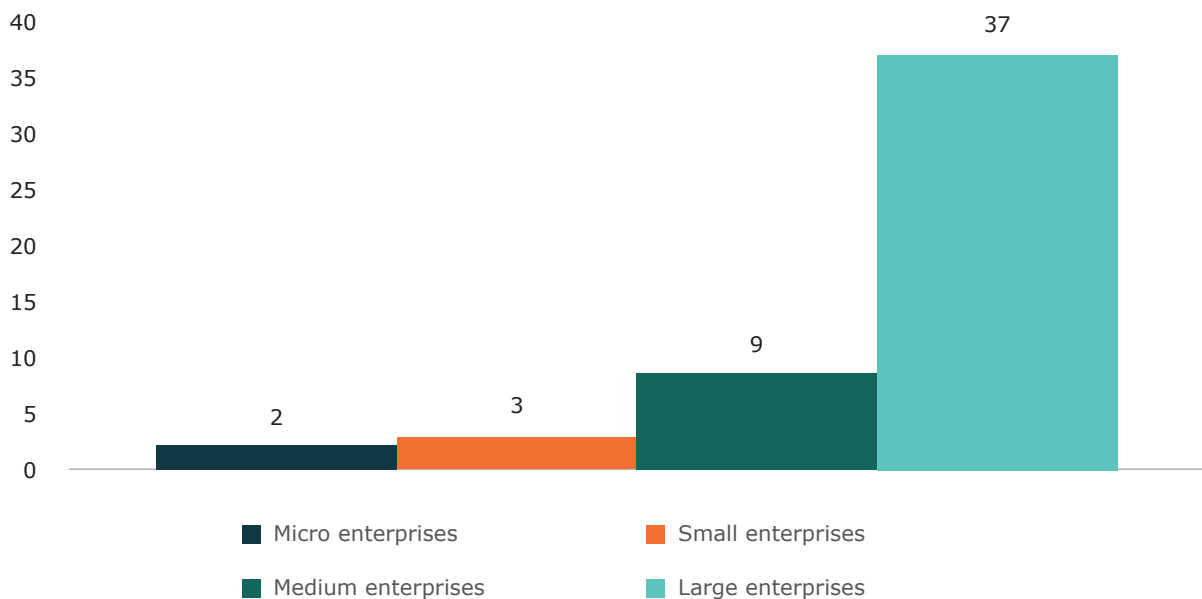


Figure 15 Average number of patents per enterprise

Conclusion

Life science is an important Danish position of strength and the industry is doing well by contributing to the national economy and innovative development. The study shows that Danish life science enterprises perform well in comparison with enterprises from other countries, but also shows that there is a gap when compared to the level of the Swiss enterprises measured per million inhabitants.

The study finds that Danish life science enterprises seem to have a strong focus on the US market, filing 21 pct. more patent applications to USPTO compared to the EPO in the period 2010-2019. The number of applications from Danish enterprises has been relatively constant over the past 10 years, and the number of patent applications to both the EPO and the USPTO has remained at a reasonably constant level. In the same period, however, the exports of the Danish life science industry have tripled. At the same time, the large increase in the number of patent applications from Chinese enterprises to both the EPO and the USPTO indicates that the level of innovation of

Chinese enterprises in the life science industry is growing significantly. This can lead to increased competition for Danish life science enterprises in the future and is a significant point of attention.

Novozymes and Novo Nordisk account for a total 25 pct. of all Danish patent applications within the life science industry, and the ten most patent-active Danish enterprises account for almost 50 pct. of all patent applications. This goes to show that the life science industry is a relatively concentrated industry. However, in comparison with other of Denmark's position of strengths, the ten most patent-active enterprises in the green tech industry account for as much as 73 pct. of all Danish patent applications to the EPO, with Vestas and LM Wind Power combined accounting for 47 pct. of all patent applications. Comparing the Danish life science industry with the green tech industry, the innovation in the life science industry is not nearly as concentrated. Lastly, the analysis shows that half of all patent-active enterprises in life science are micro-enterprises.

Methodology

The study examines the performance of Danish enterprises in life science industry as measured by patent application activity in the EU and the USA.

In order to standardize the procedure in the extraction of life science patent applications, a data cluster is used to define the fields of technology. The data search is performed by using patent applications from several subclasses that cover all life science technological fields. The study is based on published patent data from the PATSTAT online database. The data used is based on the Danish Patent and Trademark Office's professional knowledge within the different fields of technology in the life science area. PATSTAT online is updated twice annually and all data used in this study has been retrieved from the database version from spring 2020.

The study is based on data consisting all the patent applications filed to EPO and USPTO and published within the period 2010-2019. Overall, each application represents an invention, though there may be special cases that deviate from this general trend. As part of the analysis, the applications have been classified by place of origin based on data on the applicant's geographical location and form the basis for a comparison of life science technology developments in different regions of the world.

IP5 index

The study uses a modified version of the OECD IP5 Index, which covers the world's five largest markets in terms of IP filings (USPTO, EPO, China, Japan, and South Korea). For the purpose of this report, patent applications are only included in the analysis if they are filed with either the EPO or the USPTO and with one or more of the other IP5 patent offices.

The purpose of the IP5 indicator is to minimize the bias associated with making an analysis based on EPO applications alone as well as excluding patents of little or no commercial value. This comes from the fact that patenting is expensive with costs increasing with every new country where the patent application is filed.

The method applied still has a slight bias, favouring countries that routinely patent with the EPO or the USPTO. For instance, given the size of the Chinese or Japanese market, many Chinese or Japanese enterprises may favour

the Asian market, therefore mainly filing their patents within Asia. The method used therefore has the implication that a patent filed by a Japanese enterprise with the Japanese and Chinese patent office has not been included in the analysis. A patent filed by an American enterprise with the EPO and the USPTO has, however, been included in the analysis.

Data behind the IP5 index indicator is only available until 2015 due to the way data is structured and registered in the PATSTAT database. This means that it does not provide a good indication of the most recent trends in patenting. To overcome this problem, patent applications filed with either the EPO or the USPTO has been used for certain parts of the report. This makes it possible to analyse the development of life science patent applications until 2019. Throughout the report, applications from private individuals are filtered out so that only applications from enterprises are included.



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